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Tube Welding by the Oxy-Acetylene Process

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The art of tube welding is of very recent development; in fact, it has grown from practically nothing into an important industry within the short period of the past five years. The reasons for this remarkably rapid growth are to be found in the high quality and low cost of welded tubing.

TUBING, considered merely as a structural shape, has the greatest strength in compression and bending to be obtained from any shape of equal cross-sectional area. Likewise, it is one of the most convenient shapes known. In large work this fact has been applied for years in the use of round cast-iron columns and standard commercial wrought-iron pipe of various weights, but until the advent of welded tubing nothing but drawn seamless tubing was available for weights lighter than pipe and its price has been prohibitive for ordinary purposes.

When the oxy-acetylene welding process offered a means of producing the substitute for drawn seamless tubing in the form of welded tubing of thin gage, numerous manufacturers were so well impressed with the possibilities of this line of work that they went into it on a large scale. As a result, the product of the oxy-acetylene tube-welding process is of such excellent quality and is produced so much cheaper than drawn seamless tubing that it is rapidly superseding the latter form of tubing for very many purposes.

Tubes welded by the oxy-acetylene process are almost invariably butt-welded; that is, in the tubes as formed up, the square edges lie butt to butt. The heat is applied to the seam only and must be of an intensity to raise the edges immediately under the flame to the fusing point. The edges are then pressed together while in a molten condition and flow into each other, forming a true and homogeneous weld. The weld may be upset or reinforced, if so desired, to a greater thickness than the original tubing wall by compression of the seam at the point of weld.

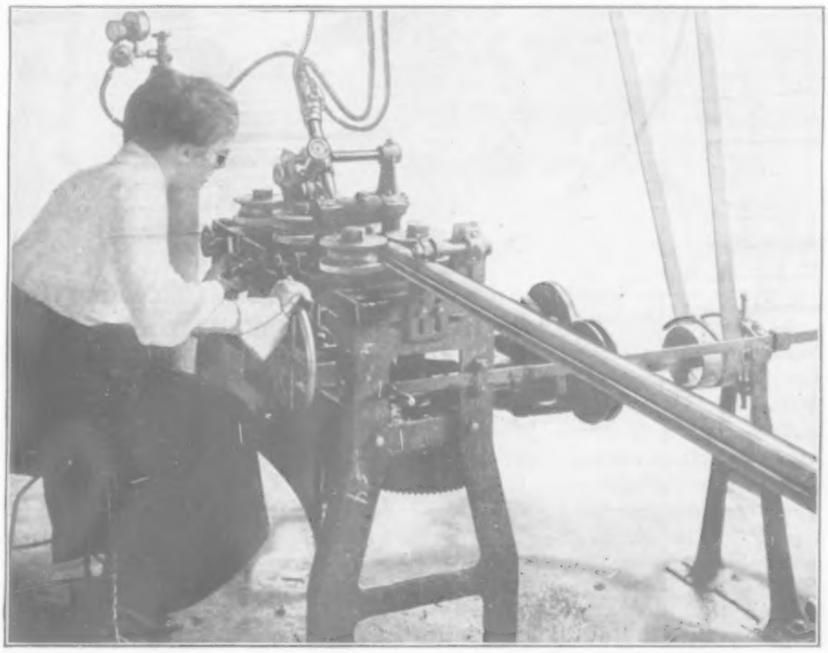


FIG. 1. FEEDING END OF TUBE-WELDING MACHINE WITH OXWELD MULTIPLE-JET ACETYLENE TORCH

As the uses of tubing are principally structural, the material from which it is made is usually low-carbon steel, although this is not used as universally as might be expected because old high-carbon rails make an excellent and comparatively cheap raw material for the manufacture of tubing by the hot formed process, where a smooth and polished surface is not required.

The low-carbon steel tubing may be made from either hot- or cold-rolled stock. By far, the largest amount is made from cold-rolled sheet on account of its smooth

finish and good appearance. Other metals can be machine-welded satisfactorily, but where they are ductile as in the case of brass and copper, it may be cheaper to make them by seamless drawing.

Low-carbon steel is usually purchased from the mills in the shape of strips or sheets which can be rolled and sheared accurately to the required dimensions. Gang shears reduce the sheet to strips of accurate width in one operation. The tubing is formed cold by first rolling it to semi-circular form and closing it in to the circular form either in a conical drawing die or by further reductions in size between rolls, the latter being generally the preferred process because it eliminates subsequent warping at the seam.

Rails from which high-carbon tubing is usually worked up, are broken into the correct lengths to produce a 50-ft. skelp, heated in an ordinary heating furnace and broken down to rectangular section of the desired gage and width by a series of rolls of the usual rolling-mill type. The skelp is then passed, while still hot, through a pair of rolls which form the section to a half circle and force it through a conical die which draws in the edges to the final complete circular section required for tubing.

Owing to the inaccuracies of this type of mill, the gage and width of the skelp, which latter dimension determines the diameter of the tubing, cannot be held to any close accuracy, and, consequently, this type of tubing is used only for purposes where exact size is not important, such as bedstead frames, handles for tools, and the like.

Machines for tube welding consist, in general, of a table with frame, or housings, upon which is mounted the feeding mechanism and its drive; above this, a gas-torch holder equipped with a horizontal adjustment at right angles to the seam, another in the direction of the axis of the torch and a hinged arrangement by which the torch may be lifted away from the work.

There are two general types of feeding mechanism, one of which, covered by the Lloyd patents, consists of a continuous or endless-chain arrangement. Two chains are required, one on each side of the tube, each link carrying a block with a groove in its face to fit the tube. Two corresponding blocks, when moved forward between rolls upon which the endless chains are mounted, catch the tube between jaws and carry it forward at a uniform rate of speed, at the same time compressing the seam the desired amount to secure a satisfactory weld.

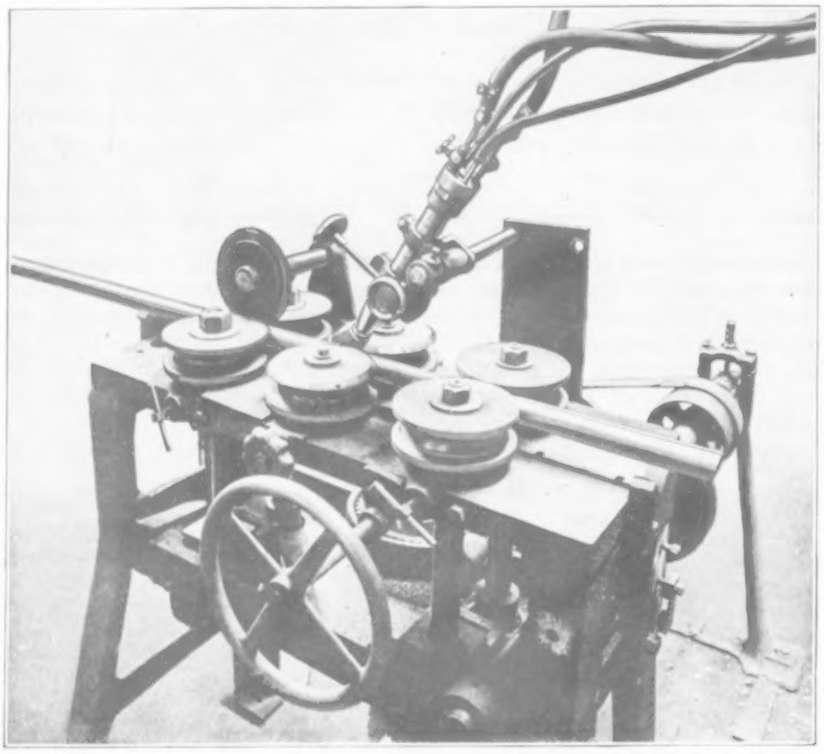


FIG. 2. THE LEFT SET OF ROLLS FEED THE TUBING WHILE THE SPREADER DISK OPENS THE SEAM SLIGHTLY

The central rolls hold the tubing to specified diameter while welding and the right set of rolls act solely as guides

The other, and more generally used method, shown in Figs. 1, 2 and 3, employs two trains of rolls, three on each side, having grooved surfaces to fit the tubing. The middle pair, known as the welding rolls, are chamfered away on the top side to allow the welding flame to work in between them. The forward and rear pairs are used merely as feed and guide rolls. In order that different sizes may be welded on the same machine, rolls having grooves of varying depth are provided to fit the various diameters of tubing to be welded. Provision is also made for opening and closing the rolls to get heavier or lighter welds.

Experience has shown that to secure an even and smooth seam, it is necessary to counteract the effect of unequal expansion by spreading the seam open $\frac{1}{32}$ in., more or less, about 6 in. ahead of the welding rolls. This is generally accomplished by mounting a thin disk abreast of the forward guide rolls at such a distance that its lower edge will enter and spread the seam apart

the necessary amount to secure this smoothness of weld. This disk also answers the purpose of aligning the seam under the flame.

The drive should be arranged to give different speeds in order that the machine may be used on different types of welding, but should be of such pattern that

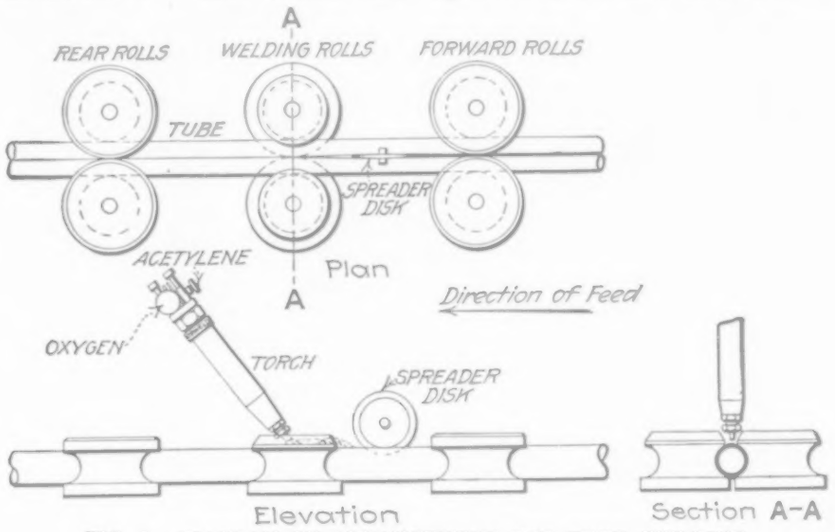


FIG. 3. DIAGRAM OF ARRANGEMENT FOR TUBE WELDING

when once the speed is set, it will remain closely uniform.

There are two general types of oxy-acetylene torches in use, corresponding to the two schools of oxy-acetylene practice; namely, the low-pressure and pressure types. The low-pressure type is by far the more successful in welding operations owing to the "softness" of the flame. This softness is inherent and due to the low velocity of the heating gases. It also implies efficiency, as the gases passing over the metal at a low velocity have more time to give up their heat than in

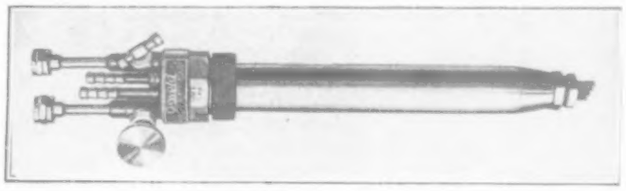


FIG. 4. FOUR-JET TYPE W-5 WATER-COOLED WELDING TORCH

the case of pressure torches. The low-pressure flame is more uniform because the acetylene is supplied from a gas bell at uniform pressure.

In the welding of heavier gages, more heat is required than for lighter work and this is secured by arranging a variable number of flames in a line progressively along the seam to be welded (see Fig. 4). The forward flames sucessively raise the temperature of the tube to such a point that the last flame will fuse the metal just abreast of the welding rolls which compress the fused edges together, forming a perfect weld. For welding tubing of 14 gage, as high as nine or ten flames have been successfully employed and with this number of flames a welding speed of 5 ft. per minute can be obtained. With such a concentration of heat, water-cooling is necessary to maintain a uniform flame and eliminate backfiring or ignition of the gases within the tip. The torch proper is always water-cooled to secure uniformity of flame and for the comfort of the operator.

For the heavier work, mentioned above, the possibilities range down to 22- or even 24-gage metal, upon which a single flame torch, Fig. 5, may be employed. Short samples of welded tubing are shown in Fig. 6.

After welding, if it is desired to secure a very exact diameter, either externally or internally, this is accomplished by drawing. The operation is performed on the draw bench which consists of a long frame, usually horizontal, at one end of which is a die of chilled cast iron or hardened steel. This die must be of the correct diameter and smoothly polished to produce the correct finish. It may be either externally or internally applied. When used on the inside of the tubing, it is known as a "triblet." The tubing is entered into the die or over the triblet; the end is crushed to secure a grip for the drawing mechanism, which is located at the opposite end of the bench, and the tube is then drawn through the die producing the correct size and a very smooth finish. Suitable lubricants must be applied to the surfaces of the tubes during this process.

Where only a bright finish, without exact diameter, is required, drawing is not employed—ordinary flashing or polishing methods being sufficient. If the tubing

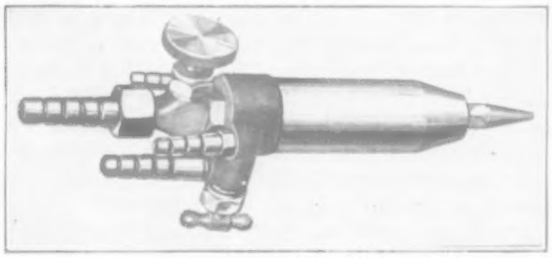


FIG. 5. OXWELD TYPE W-8 SINGLE-JET WATER-COOLED WELDING TORCH

is to be painted, or for some other reason high polish is not necessary, it is often satisfactory, if a smooth weld is secured, to use the tubing just as it comes from the welding machine.

The principal difficulties encountered in tube welding are to secure a uniform, continuous and neutral flame and to feed the tubing under the torch at a correct and uniform rate of speed at the most effective distance from the tip with the seam exactly in the flame.

The first difficulty is largely solved by the low-pres-

sure or injector type of torch which, by the proportions of its gas passages, automatically keeps the flame neutral, that is with exactly the correct amount of oxygen and acetylene to secure perfect combustion with no excess of oxygen or of carbon. The second difficulty

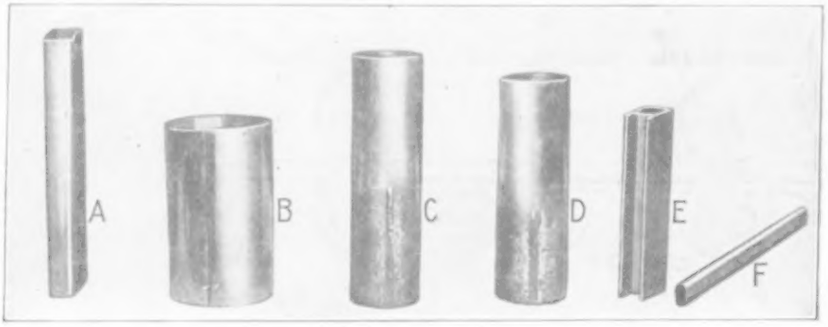


FIG. 6. SAMPLES OF TUBING WELDED BY THE OXY-ACETYLENE MACHINE WELDING PROCESS
A—Cartridge case. B—Tubing as welded. C and D—All traces of welding eliminated by grinding and polishing. E—Wind-shield frame and wedge.

is mechanical and can only be eliminated by standardizing shop conditions.

The stock strip must be held to exact width if a uniform diameter and thickness of weld are to be produced. The tolerances are determined by experience, but once set should be strictly held to. Burrs on the sheared edges must absolutely be eliminated as these get into the seam and hold it open causing "skips." When the strip is formed into tubing, care must be taken to secure a very exact adjustment of the rolls and dies or otherwise the seam in the tube will assume a spiral shape, causing difficulties in guiding the seam exactly under the flame. If the flame does not play exactly upon the seam, only one side of the seam will be fused and the weld will "skip" until the flame is correctly adjusted. Lost motion in the feed rolls and in the adjusting mechanisms of the torch holder will invariably aggravate this difficulty.

In the early days of this art, when manufacturers were content with speeds of 2 to 3 ft. per minute, it was possible for the operator to adjust his flame from side to side, follow the irregularities in the seam, and to slow down his machine when the weld showed a tendency to skip. With the speeds attained in modern production, from two to four times as fast as formerly, this is no longer possible. The operation progresses so rapidly that it is humanly impossible for the operator to adjust his machine to changing conditions and, in consequence, if the seam is not perfectly true the operator must necessarily fail to get a continuous weld and even in attempting to do so he will constantly slow down his machine, thus limiting the quantities of tubing produced.

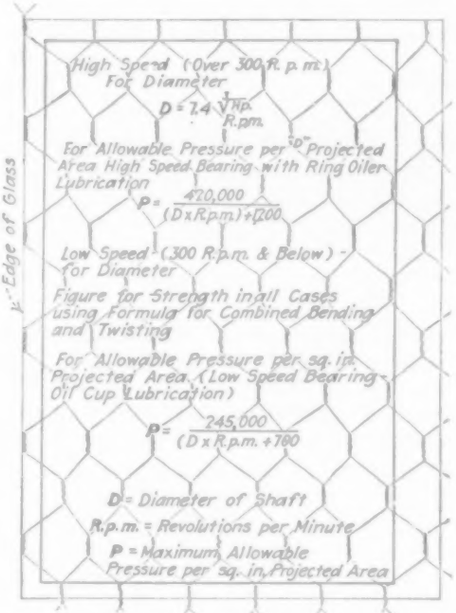
The successful manufacturers have, therefore, applied the well-known principles of scientific management to this problem and by studying the conditions under which the forming and welding are done have succeeded in so standardizing their product that the welder is not required to do anything but start the tube into the machine and keep the torch lit and the tip free from accumulations of slag and dirt. The tubing is required to come absolutely uniform in diameter and straight in seam. The set of the rollers, speed of welding and pressures of the gases in the torch are adjusted by the foreman or tool setter in charge to predetermined standards which are not allowed to be changed by the operator. If, with the machine as delivered to the operator, he cannot secure good tubing, the machine is shut down, the trouble discovered and the proper remedy applied.

By the application of such methods as these and with the full coöperation of the manufacturer of oxy-acetylene apparatus, it is not remarkable that great progress in the development of the art of oxy-acetylene tube welding should have been made within so short a time.

Wire-Glass Forms for Trimming Drawings

BY EMILY NORMAN

The illustration herewith shows the use of a wire-inserted plate-glass cutting block for trimming blueprints, photostats and other similar work accurately to


High Speed (Over 300 R.p.m.) For Diameter
D = 7.4 ∛HP. / R.p.m.
For Allowable Pressure per "P" Projected Area High Speed Bearing with Ring Oiler Lubrication
P = 420,000 / (D x R.p.m.) + 1200
Low Speed (300 R.p.m. & Below) For Diameter
Figure for Strength in all Cases using Formula for Combined Bending and Twisting
For Allowable Pressure per sq. in. Projected Area (Low Speed Bearing Oil Cup Lubrication)
P = 245,000 / (D x R.p.m. + 700
D = Diameter of Shaft
R.p.m. = Revolutions per Minute
P = Maximum Allowable Pressure per sq. in. Projected Area
Edge of Glass

WIRE-GLASS FORMS FOR TRIMMING DRAWINGS

size. The trimming is done with a sharp-pointed paper cutter on a plate-glass table top around the glass-cutting block. It is easy to trim correctly and accurately square with the drawing by lining up with the joints of the wire inserts. Blocks of various sizes are used to suit the work in hand.

Automotive Construction

The Hispano-Suiza Airplane Engine—VII

By H. C. ISENBERG
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The vast number of operations necessary in the production of the connecting-rods and the close tolerances imposed are surprising even to one accustomed to work of this character. Both bearings are finished by grinding and on these, the fits are so close that ample lubrication would seem ings are finished by grinding, and on these the speed of the engine is taken into consideration. Details of the different types of rods are given and a few of the major operations are illustrated and described. Illustrations are also shown of the rods in various stages of their manufacture.

THE connecting-rods are made from steel drop-forgings which after being heat-treated must meet the following physical properties: Elastic limit, 105,000 lb.; elongation, 17 per cent.; Brinell hardness, 260, and Fremnot or impact test of 12-kilogram meters.

The rods are of two types, American marine and French and of each type there are two kinds, inner and outer.

A detailed drawing of the inner connecting-rod is shown in Fig. 95 while Fig. 96 shows the principal stages of its production, in which *A* is the forging; *B* has the shank turned and ground; *C* has the wristpin hole drilled and reamed; *D* has been hollow-milled, faced and chamfered at the wristpin end; *E* has the cone at the crank end rough-turned; *F* has the flats at the same end milled; *G* has the cone finish-form-milled and a hole drilled through; *H* has been circular-milled

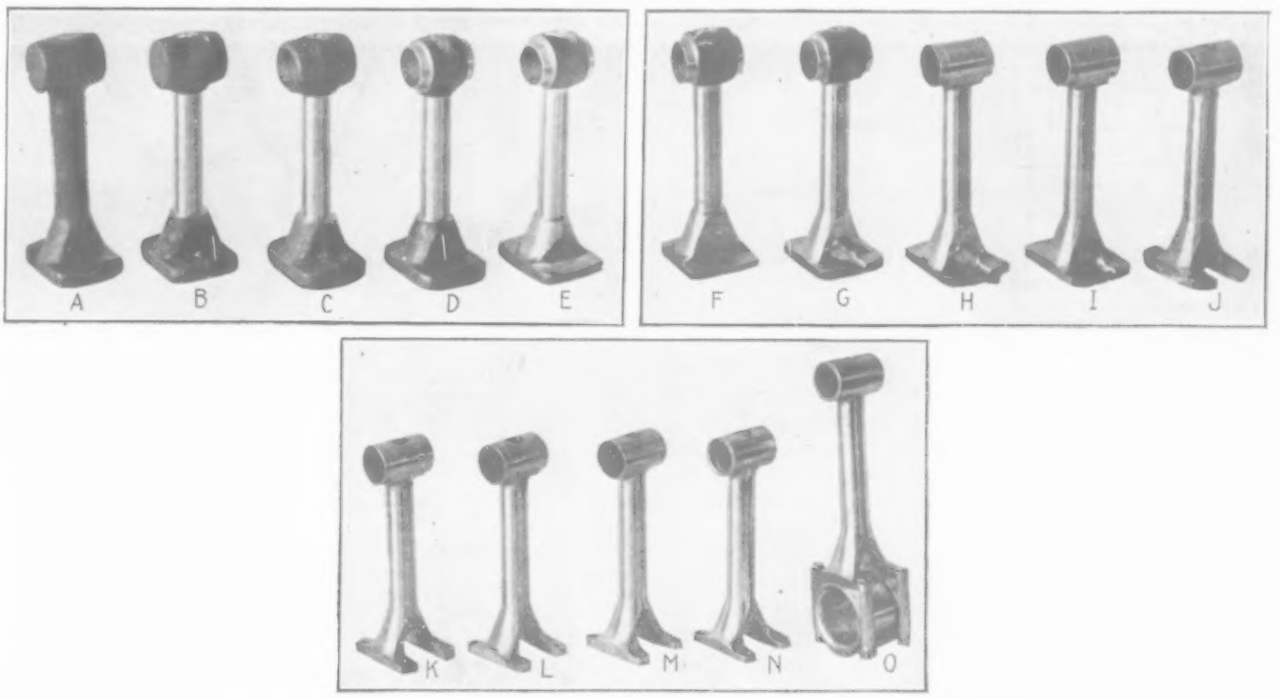


FIG. 96. STAGES IN THE MANUFACTURE OF THE MARINE TYPE INNER ROD

AUTOMOTIVE CONSTRUCTION

at the wristpin end; *I* has the flange straddle-milled; *J* has a $\frac{3}{4}$-in. hole drilled through the shank and the clearance for the outer rod cut; *K* has the clearance form-milled, the bottom of the flange ground and the bolt holes drilled; *L* has been milled to form radii about the bolt holes; *M* has been polished all over and the feet of flange ground on top to present a flat face for the bolt heads; *N* has the bronze wristpin bushing pressed in

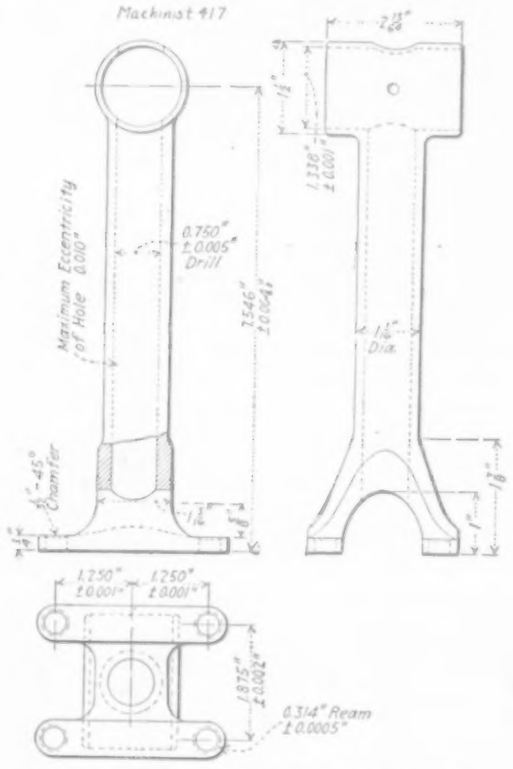


FIG. 98. THE AMERICAN MARINE-TYPE INNER CONNECTING-ROD

and ground in place, and *O* shows the rod, bearing and cap completely assembled.

Cutting out the clearance for the outer rod is done on a band saw, the arrangement being shown in Fig. 97. The bases of rods before and after sawing out the clearance are shown at *A* and *B*. The saw runs at a speed of 140 ft. per min. and the work is clamped in its fixture and is fed to the saw by a weight suspended from a cord that passes over a pulley attached to the frame of the machine. The free end of the cord is attached to the sliding table upon which the fixture holding the work is mounted. Two cuts are made, the fixture being reset for the second cut. A mixture of lard and paraffine oil is used as a coolant and the production is 160 per machine in 8 hr. with one operator. This is a roughing operation and the surfaces thus produced are afterward finished by form-milling. This clearance was formerly rough-milled from the solid but the production was only one-half of that of the band saw.

The bottom of the flange is ground in a Pratt & Whitney vertical surface-grinding machine as shown in Fig. 98, the rods being held in fixtures and located by pins passing through the fixtures and the wristpin holes as may be seen in the illustration. For the height or

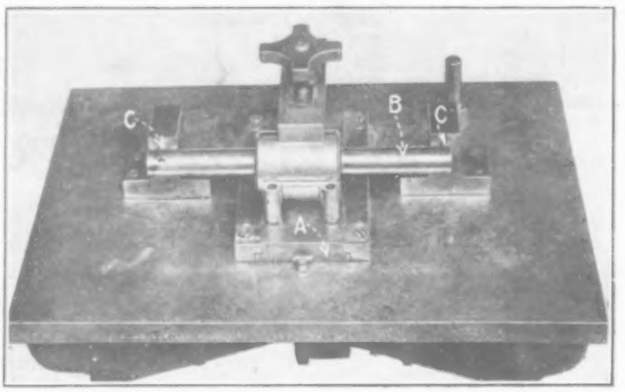


FIG. 100. TESTING A BEARING

distance from the wristpin hole to the bottom of the flange a tolerance of 0.003 in. is allowed and the gages used are a height vernier and a dial indicator. The grinding is done dry and the production is 120 per machine in 8 hr. with one operator.

Grinding the top of the flange feet is done on a surface-grinding machine, Fig. 99, several rods being held on a magnetic chuck. The tolerance here is + 0.010 in. — 0.000 in. and is gaged by a micrometer. The grinding is done dry with a Norton 46-L wheel running at 4700 ft. per min. and the production is 392 per machine in 8 hr. with one operator.

The bronze bearings which have a lining of babbitt 0.020 in. thick and must be very accurately made are not produced at this plant. As the bearings at the wristpin and crankshaft ends must be parallel in the

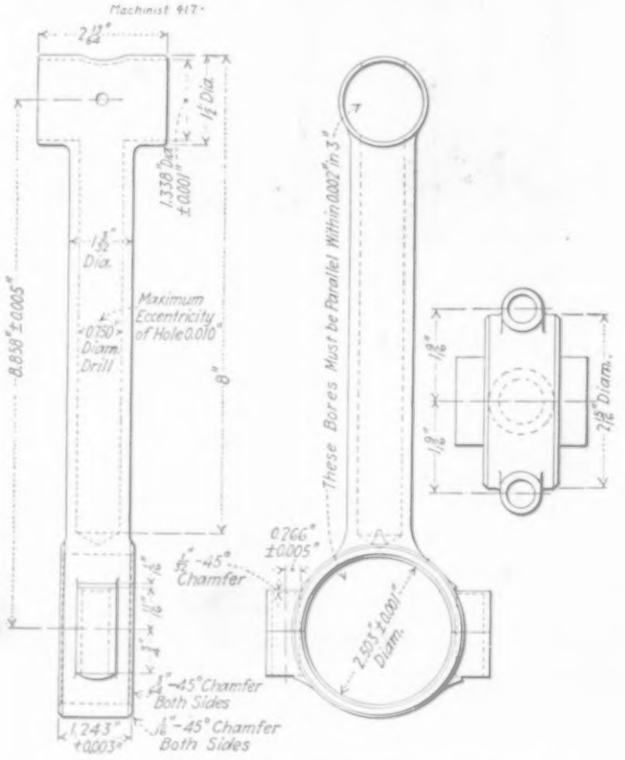
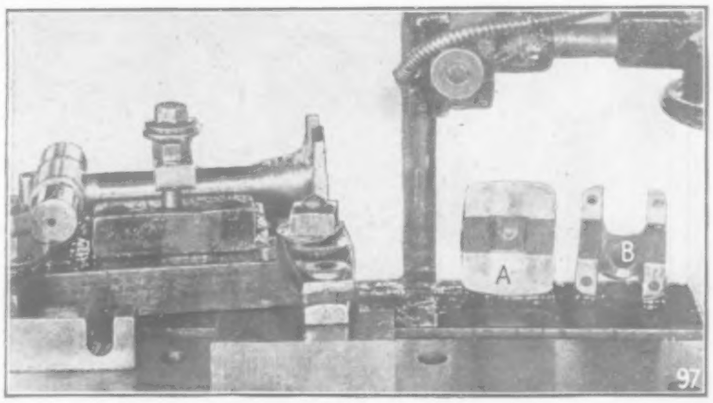
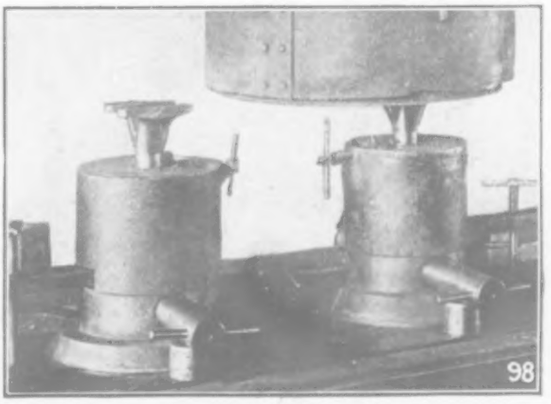
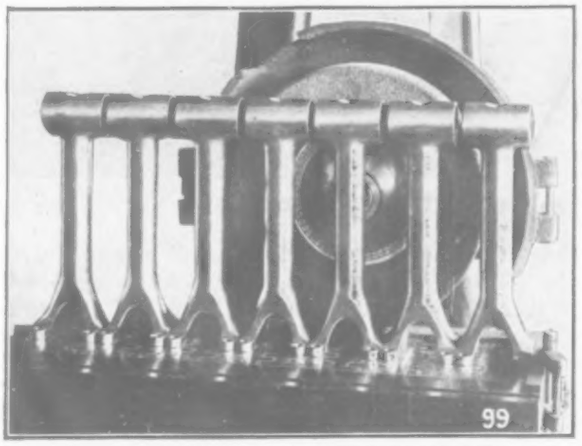


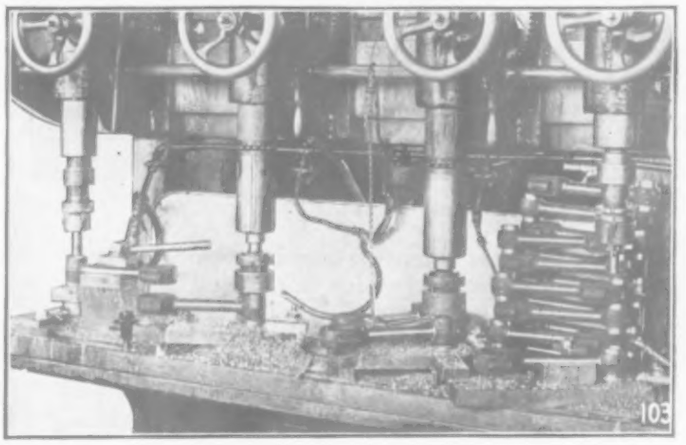
FIG. 101. THE AMERICAN MARINE-TYPE OUTER CONNECTING-ROD

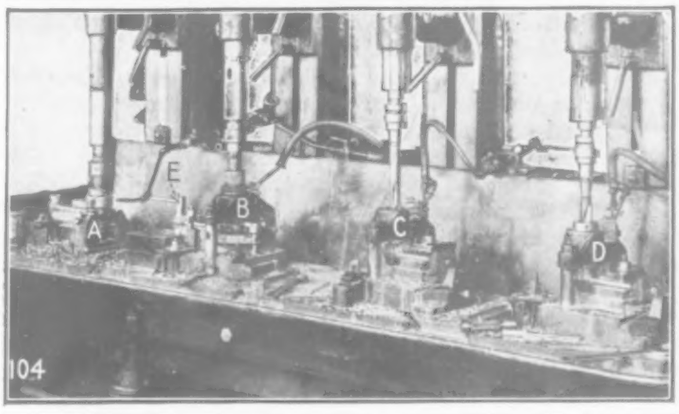
AUTOMOTIVE CONSTRUCTION

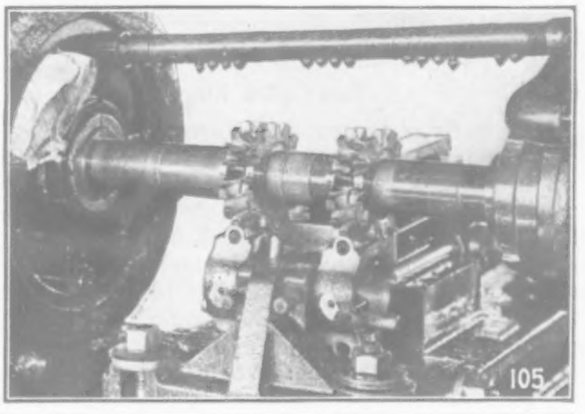


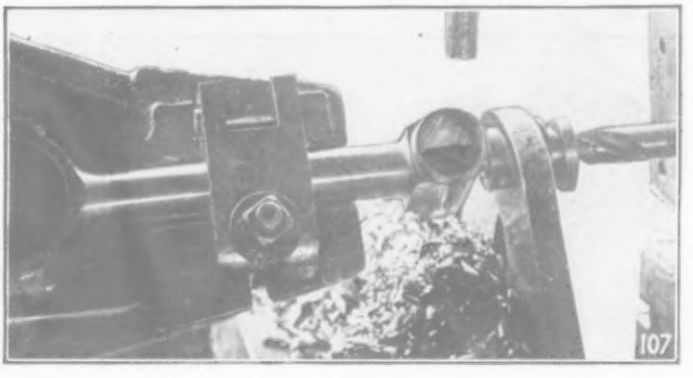












FIGS. 97 TO 99 AND 103 TO 107. OPERATIONS ON CONNECTING-RODS

Fig. 97—Cutting clearance for the outer rod. Fig. 98—Grinding flange bottoms. Fig. 99—Grinding flange tops. Fig. 103—Facing and hollow-milling the wristpin end. Fig. 104—Operations on the crank end. Fig. 105—Milling the bolt lugs. Fig. 106—Circular-milling. Fig. 107—Drilling the shank.

AUTOMOTIVE CONSTRUCTION

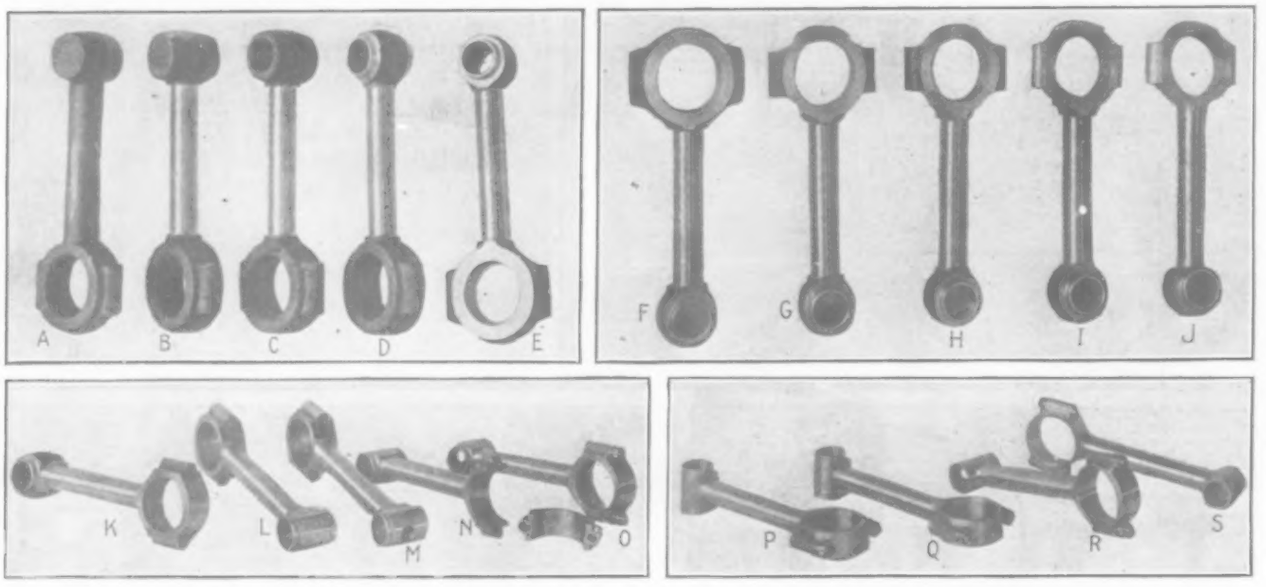


FIG. 102. STAGES IN THE MANUFACTURE OF THE MARINE-TYPE OUTER ROD

assembled rod these lower bearings are required to pass a very severe inspection and for this purpose are placed in the gaging fixture shown in Fig. 100.

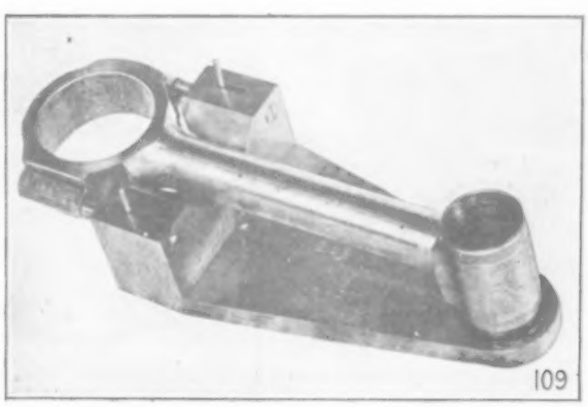
The two halves are placed on four pins on the sliding block *A* and there clamped with the hardened and ground rod *B* between them. This gages the correctness of the bolt holes and the bearing for the crankpin. The sliding block *A* is then moved so as to bring the bar *B* in contact with the flush-pins *C*. The tolerance allowed is 0.003 in. in the length of the bar.

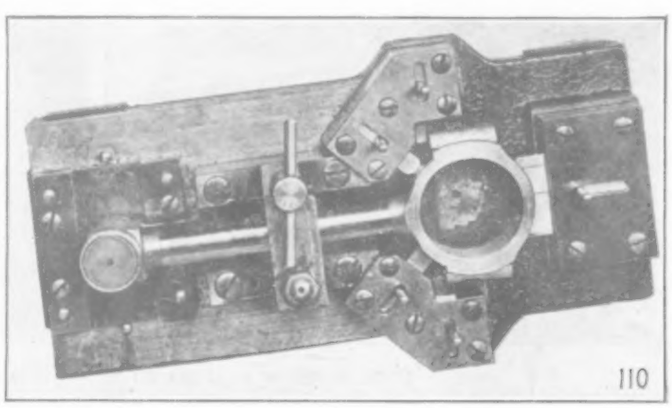
The Outer Rod

The details of the outer rod are shown in Fig. 101 and its various stages of progress may be seen in Fig. 102 in which: *A* is the forging; *B* has the shank turned and ground; *C* has the wristpin hole drilled; *D* has been hollow-milled, faced and chamfered at the wristpin end; *E* has been rough-faced at the crank end; *F* has the hole at the crank end rough-bored (this hole is not round but is slightly elongated in the direction of the rod axis so that after the cap is cut from the rod by a band saw, the hole will be approximately round when these two parts are brought together); *G* has radii milled at the ends of the bolt lugs; *H* has the bolt lugs drilled; *I* has the bolt lugs form-milled; *J* has been rough-turned at the junction of the stem and the crank end; *K* and *L* have the remaining stock milled from both ends; *M* has the shank drilled to lighten the rod; *N* shows the rod and cap sawed apart; *O* is the rod assembled ready for final finishing; *P* has been circular-milled between the bolt lugs; *Q* has the crank end chamfered; *R* has the crank bearing ground, and *S* has the wristpin bushing assembled and ground in place.

Facing, rough- and finish-hollow-milling and chamfering is done in a four-spindle drilling machine. The work is held in fixtures on a Foote-Burt four-spindle drilling machine as may be seen in Fig. 103. "Go" and "not go" snap gages are used for gaging the hollow-milling operations while for the facing, special gages are required using the shank of the rod as a starting point. The tolerances are on finish-hollow milling 0.003 in. and on facing 0.005 in. Oakite is used as a coolant and the production will average 80 per spindle in 8 hr. with two operators on the machine.

Fig. 104 shows the operations of semi-finishing the face of the crank end at *A*, boring the elongated hole





FIGS. 109 AND 110. FLUSH-PIN GAGES FOR FINAL INSPECTION

AUTOMOTIVE CONSTRUCTION

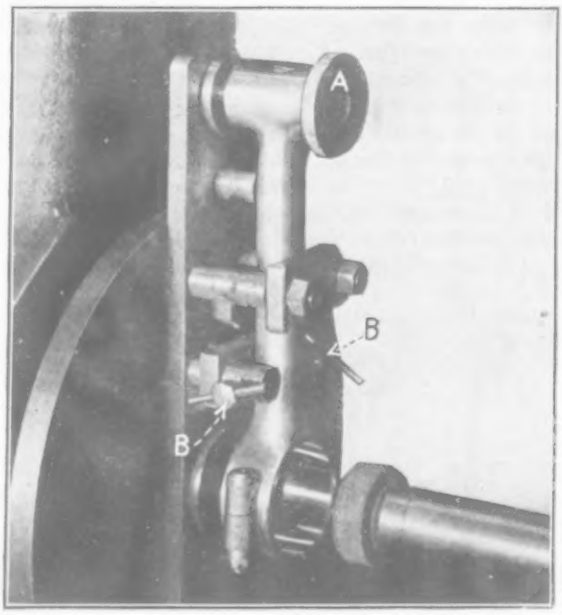


FIG. 108. GRINDING THE HOLE AT THE CRANK END

at *B* and drilling and finish-reaming the wristpin holes at *C* and *D*. In boring the elongated hole two cuts are taken, one from each of two positions which are located by the pin *E*. The elongation is 0.032 in., the purpose of which has been explained. For the finish-reaming a "go" and "not go" plug gage is used and the tolerance is 0.001. For semi-finishing the face a "go" and "not go" snap gage is used with a tolerance

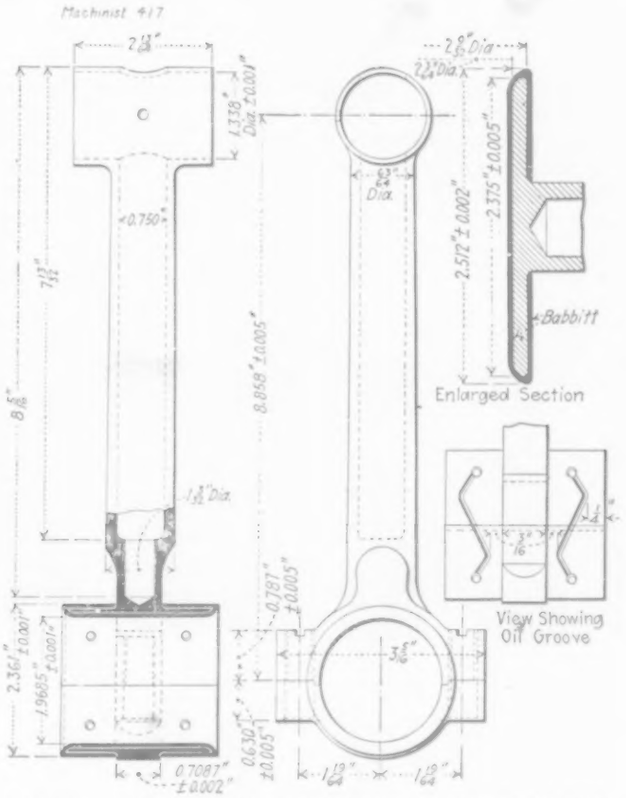
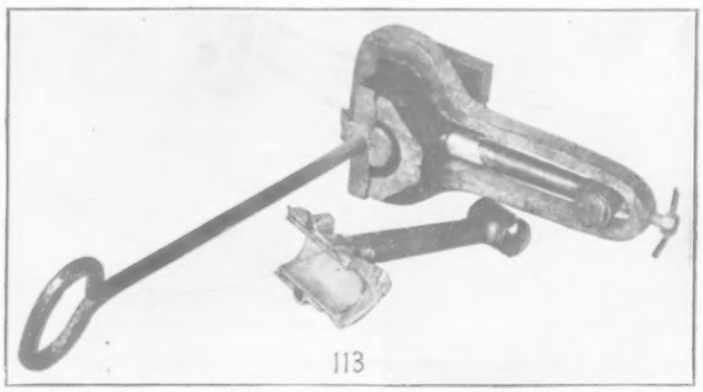
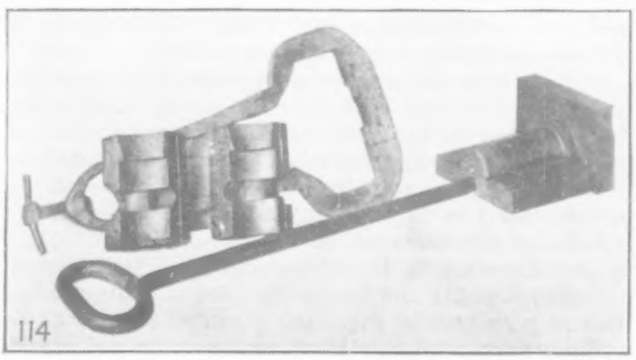
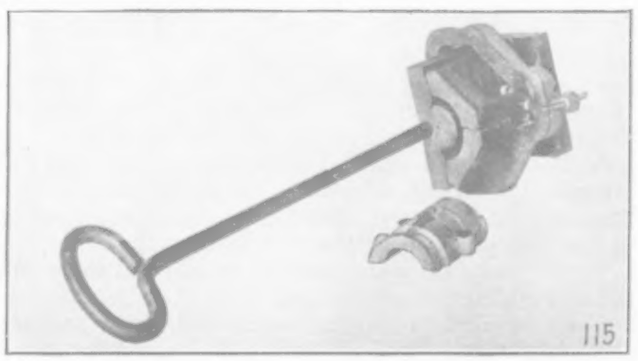


FIG. 111. THE FRENCH-TYPE INNER CONNECTING-ROD

of 0.005 in. Oakite is used as a coolant and the production is for facing 120, boring elongated hole 60, and







FIGS. 113 TO 115. BABBITTING MOLDS

Fig. 113—Mold assembled with rod in place. Fig. 114—Parts of the mold. Fig. 115—Mold for the cap

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drilling and finish-reaming 50 for two spindles in 8 hr. with two operators on the machine.

Milling the bolt lugs is done in a Briggs milling machine on two rods at a time with interlocking formed milling cutters as shown in Fig. 105. Gaging is done with a micrometer and the distance across the lugs has a tolerance of 0.005 in. A mixture of No. 2 mineral lard and paraffine oils is used as a coolant and the production is 80 per machine in 8 hr. with one operator.

Circular-milling the wristpin end is shown in Fig. 106, the rod being located by a central stud in a Becker vertical-milling machine. No gages are used as the depth of cut is made to the surface left by the hollow-milling. Oakite is used as a lubricant and the production is 80 per machine in 8 hr. with one operator.

A $\frac{7}{64}$-in. hole is drilled in the shank of the rod to a depth of 8 in. and afterward this is reamed to $\frac{1}{4}$ in. The set-up in the turret lathe for this operation is seen in Fig. 107 which shows the work held by the shank in a V-block fastened to the machine spindle and the drill guided by a stationary bushing.

The hole must be both concentric and to the proper depth within 0.010 in., an indicator being used for testing the concentricity, and a plug "go" and "not go" gage for the diameter of the hole. The production is 40 per machine in 8 hr. with one operator.

The holes are finished in a Bryant grinding machine of the chucking type. Fig. 108 shows the operation of grinding the hole at the crank end. The work is held in the fixture as seen in the illustration and located for center to center distance by the pin *A* which is eccentric at the end in the fixture. This provides for an adjustment of 0.010 in. either way for centering the hole. Lateral adjustment is made by the screws *B*. The tolerances are for center distances 0.005 in. and for diameter of hole 0.001 in. A 48-K wheel $2\frac{1}{2}$ in. in diameter and $\frac{3}{4}$-in. face running at 3000 ft. per min. is used with Economy grinding compound as a coolant.

FIG. 112. STAGES OF MANUFACTURE OF THE FRENCH-TYPE INNER ROD

The wristpin hole is ground in the same type of machine, but as this is done after the bronze bushing has been pressed in, the grinding is on bronze instead of steel. The accuracy required in the production of these rods may be realized by inspection of Figs. 109 and 110 which show two flush-pin gages for final inspection in which the tolerances are 0.005 in.

The French type inner connecting-rod is shown in detail in Fig. 111 and the various stages of its production may be seen in Fig. 112. The operations on this rod are very similar to those on the inner rod of the marine type except where the rods differ in design. Therefore, with the exception of these differences, to enumerate all the stages of production and to describe

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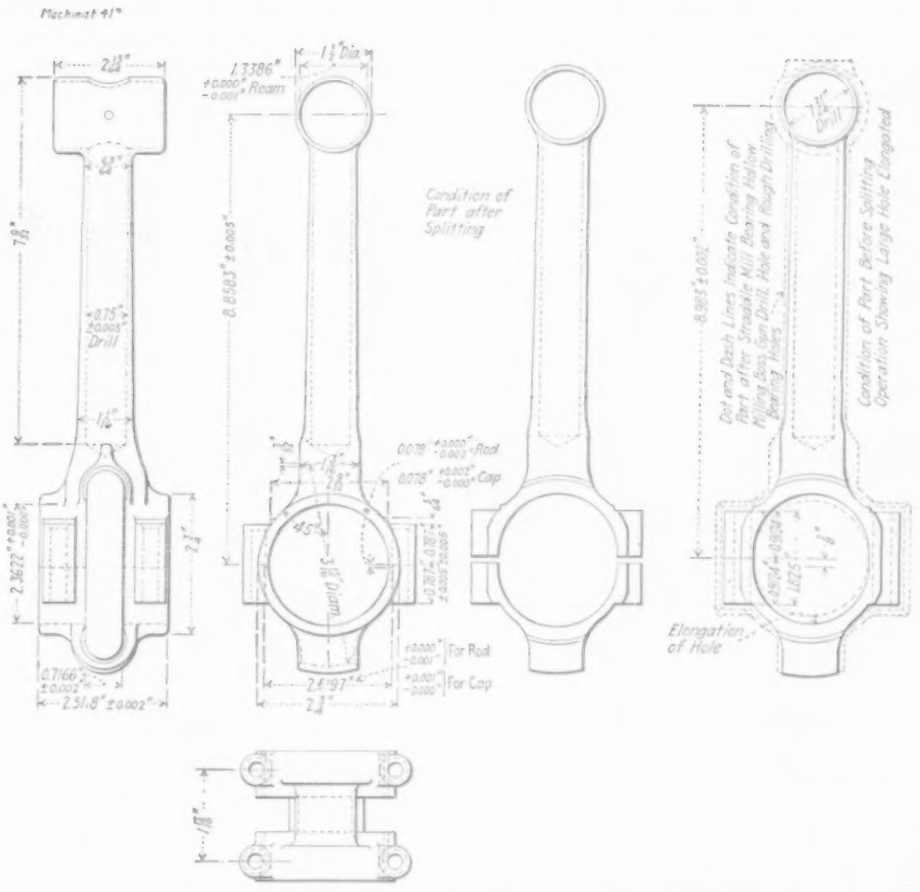

FIG. 117. THE FRENCH TYPE OUTER CONNECTING-ROD

the operations would only be to repeat what has already been said in connection with the inner rod of the marine type.

As will be seen in the drawing, Fig. 111, the crank bearing is an integral part of the rod and is both lined and covered with babbitt and after the cap has been sawed from the rod, grooves are milled on each side of the bearing which fit over corresponding tongues on the rod. For holding the babbitt eight holes are drilled in the bearing and slightly countersunk both inside and outside.

BABBITTING THE CRANK BEARING

As has been found by experience, to babbitt these rods and have the babbitt adhere tightly to the steel is a task requiring unusual precautions and the method adopted is as follows: Dip in soda solution and rinse in clean water; roll and squeeze corks to fill the bolt holes; dip in a bath of equal parts of nitric and muriatic acids slightly diluted with water; dip in clean water and remove corks from bolt holes; clean with sand and water on a revolving brush after which do not touch with the hands; dip in a saturated soluton of zinc chloride and water; recork the bolt holes; dip in pure molten tin at 800 deg. F. and hold there for 10 min.; dip in a molten mixture of 67-per cent. tin and 33-per cent. lead at 500 to 550 deg. F.; then dip in the zinc-chloride solution and again into the molten tin and lead and hold there until the rod is quite warm; shake

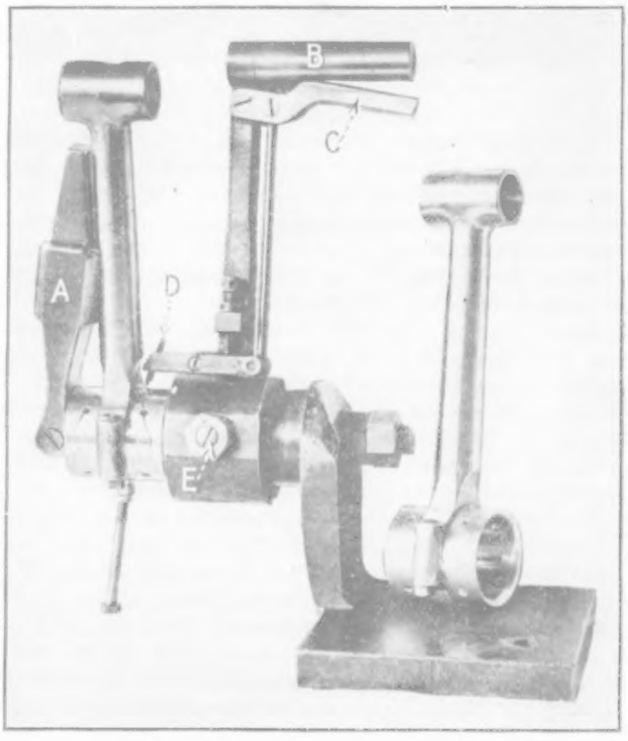

FIG. 116. TOOL FOR CUTTING OIL GROOVES

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off the excess tin and lead and drop the rod in cold water; when cold, scrape the lead and tin from the edges; clean out bolt holes and recork them with the same corks used before; clean and brush off any burnt cork; do not touch with the hands; insert at once in the mold, do not clamp too tight, lute all the mold joint so that no babbit can leak through; place in an oven heated to 850 to 900 deg. F. and keep there for 10 min.; immerse the mold containing the rod in molten babbit and keep there until all bubbling ceases, and the mold reaches the same temperature as the molten babbitt; skim all dross from the babbitt and then take out the mold and chill quickly in water.

Figs. 113 and 114 show the mold for babbitting the rod, both assembled and disassembled, while Fig. 115 shows the mold for babbitting the cap.

After machining the babbitted bearing, oil grooves are cut on the outside for lubrication of the outer rod which has its crank-end bearing at this point. This is accomplished by the bench tool illustrated in Fig. 116.

With the part *A* in a horizontal position the rod can be slipped over it and on to the locating stud. Turning *A* to the positon shown in the illustration confines the rod on the stud. *A* has a rounded groove in the upper part where it contacts with the rod stem and acts as a locating point for the rod. In use the rod and part *A* are gripped with one hand and the handle *B* and latch *C* with the other. This action brings the tool *D* into the cutting position and a downward movement of the handle *B* cuts the groove, the path of which is determined by a cam located under the screw *E*. By reversing the position of the rod on the stud and by positioning the rod so that the stem points downward instead of upward it will be seen that the grooves can be cut all around on both sides. A rod, before the grooves are cut, is shown at the right of the illustration, Fig. 116.

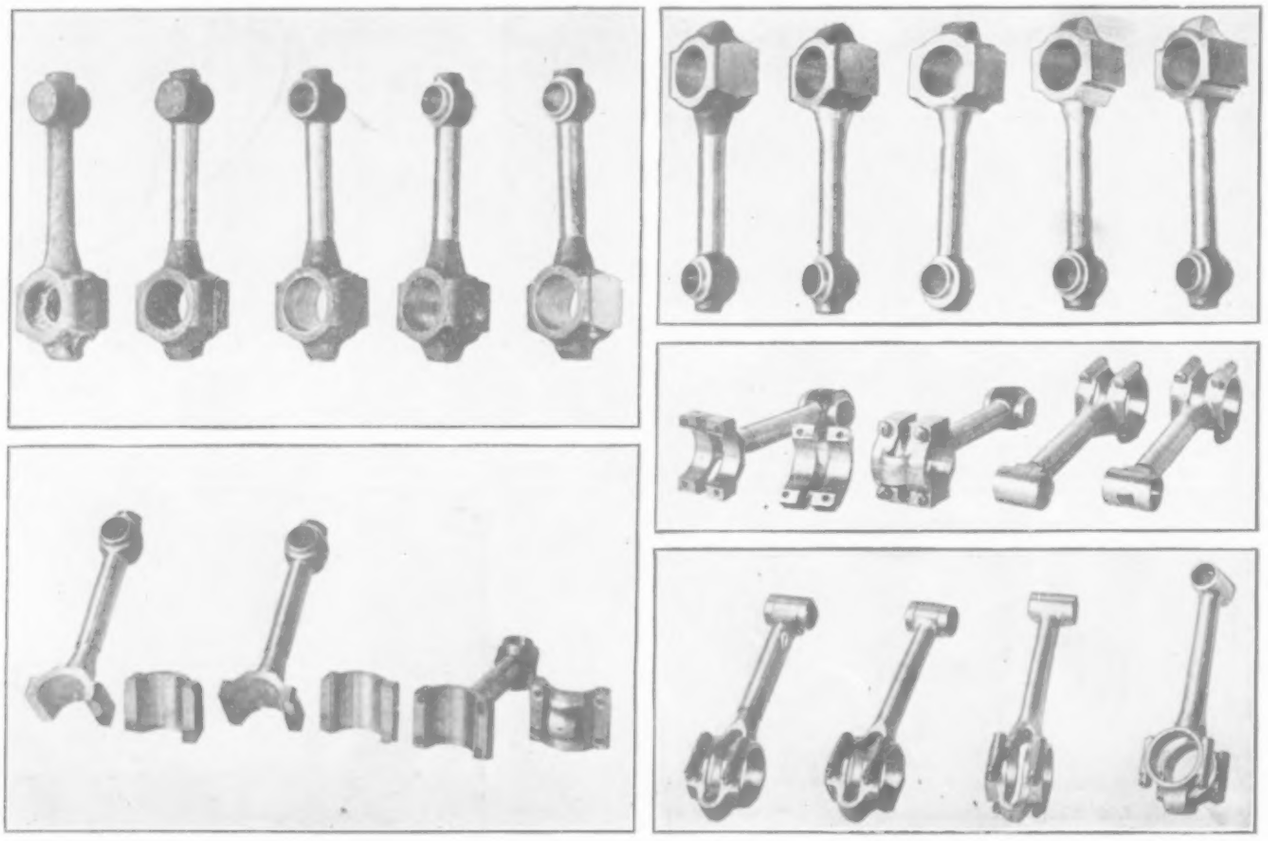


FIG. 118. STAGES OF MANUFACTURE OF THE FRENCH-TYPE OUTER ROD

The details of the outer rod are shown in Fig. 117 and the different stages in the course of its manufacture in Fig. 118. The principal operations on this rod are similar to those on the marine-type outer rod.

British Engineers Use Technical Press

The British Engineering Standards Association is beginning to use the technical press as a means of securing the opinions and practices of engineers and manufacturers. The association which only takes up questions on the advice of and with the coöperation of manufacturers in Great Britain, seems in a fair way to advocate the adoption of the standard-hole practice which is so common in this country. It is undecided, however, whether the tolerance shall be both positive and negative or whether the minimum shall be the nominal size, with only a positive tolerance. The latter seems to be more popular with machine-tool builders.

The move toward standardizing milling-machine-spindle noses is of interest. Herbert and Brown & Sharpe are along the same line, while the Associated British Machine Tool people have put forward what is essentially the Cincinnati design.

Heat-Treatment Room Operators—Their Part

By W. H. ADDIS

It is very important that the man in the heat-treatment room—the furnace operator, and all of his helpers—be constantly on guard so that everything variable, everything that might cause a lack of uniformity in the finished work can be prevented. It is to help attain this end that this article is published so that the men who do the work may all profit by these simple, yet important suggestions.

HEAT-TREATMENT, to be successful, must be uniform. In these days of intense commercial rivalry, captains of industry depend upon their chemical and physical research laboratories to tell them why their product is bad or good. The old idea of trade secrets and private formulas, which were once so common in the steel industry, are no more. Today, the palm of commercial prestige falls to the house whose product most uniformly and consistently meets all of the required characteristics.

To do this, the product must pass the most exacting determinations. Tests have been devised which unerringly check every characteristic of heat-treated steel. Powerful machines literally pull the specimen to pieces, and in this operation, the elongation, reduction of area, elastic limit, and ultimate tensile strength are determined. The specimen may then be ground, polished and burnished, acid etched, and placed under the searching eyes of the microscope where further revelations will be seen, and made a matter of permanent record by the aid of micro-photography. But modern science does not stop here; many other tests may follow, such as the Brinnell hardness test, the Izod impact test, the Charpy notch test, and the Scleroscope test. In fact, the whole story of previous heat- or mill-treatment may be unraveled like a ball of yarn.

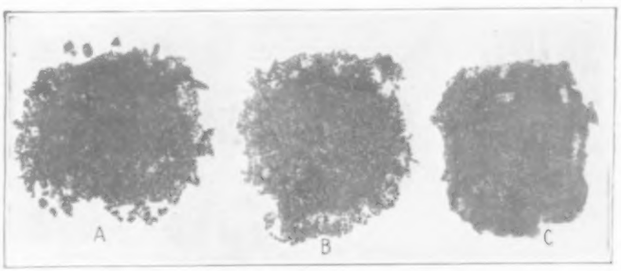


FIG. 1. CARBURIZING COMPOUNDS OF VARIOUS GRAINS

In carburizing or case-hardening, it is important that serious consideration be given to the selection of the carburizing materials, since the obtaining of satisfactory results depends upon the chemical contents and the depth and speed of penetration. The compounds that are enjoying the greatest favor in this country are for the most part of uniform quality and are composed largely of oak charcoal, petroleum coke, potash, barium carbonate, and ground filter bone, or hydro-carbonated bone black.

These ingredients may be so proportioned that they will make either a very fast or a slow carburizer. The penetration speed of a compound may be due to its granular size, the quantity of energizing carbonates it contains, and its ability to absorb and retain the evolved gases in the presence of the work until a carburizing temperature of 1550 to 1750 deg. F. is reached and a proper depth of penetration accomplished.

Compounds should be ground and blended with direct reference to the work to be carburized. At *A*, Fig. 1, is shown a very coarse rapid compound suitable for rapid and deep carburizing of heavy work. The compound *B*, of much finer granulation and containing less energetic materials, is the type that should be used on small parts and those having delicate sections. Such a compound will be much slower in its penetration but the case will be of a fine close grain and will stand up well under service. Some compound *C* is shown which has been run through a feed grinding machine and ground to a meal. This meal compound is best suited for very small parts of delicate and intricate design and insures an actual contact of the compound.

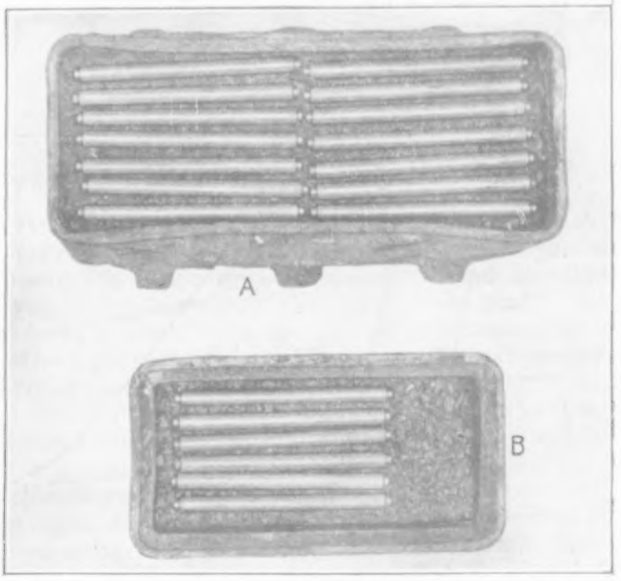


FIG. 2 WELL AND POORLY SELECTED POTS

It is well to be always on guard when using a highly energized, fast compound, for the case is generally coarse, crystalline and granular in appearance, and under most working conditions gives very poor service. This is particularly true where a marked line of demarkation is seen between the case and the core which generally results in the case peeling away from the core. However, there have been cases where under rough and dirty conditions of service, a coarse granular case stood up far better than that which showed a fine grain and an ideal shading away of case carbon into the core. If these suggestions regarding the compound are followed they will do much toward correcting many cases where there is lack of uniformity.

Where the pot-packed method is used, the selection of the pots should be approached in the same careful manner as has been outlined concerning the compound. This simple feature is a fruitful cause of trouble.

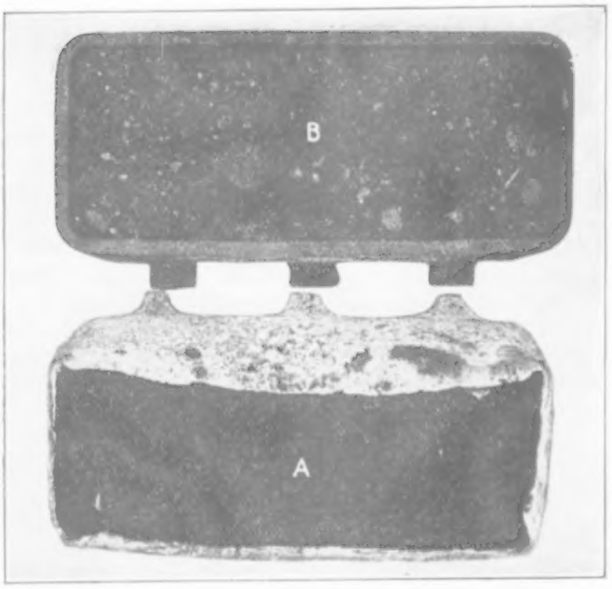


FIG. 3. A COMPARISON OF OLD AND NEW POTS

The pots should be of such size as to insure the carburizing of the greatest quantity of work and the best quality of case within the shortest practical furnace time. These are the elements that should enter into pot design and they will be best determined by careful experimental test. A pot which is well selected for the work it contains is shown at *A*, Fig. 2; while it is evident that the pot shown at *B* has been poorly selected. If the latter is used, there will be not only a great waste of pot and furnace space, with loss of production, but a likely possibility that the case will be very uneven, due to the fact that the end of the pot which contains nothing but carburizer will reach its penetration temperature some time ahead of the opposite work-filled end. If this occurs 10 min. sooner and the penetration speed of the compound is 0.001 in. per minute, the result will be that the work will have an excess case of 0.010 in. on the ends nearest the end of the pot containing the compound.

Another common cause of irregularity in pot-packed work is the practise of mixing pots of all degrees of wear in the same heat. Old, badly scaled pots, which have become thin-walled should never be mixed with new pots. The workman to whom is given the task of pot selection has an important job. The pots that make up a furnace heat should be of about the same weight

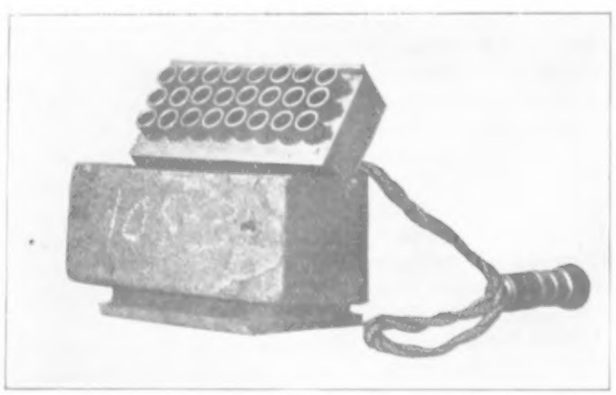


FIG. 4. THE MAGNETIC PACKING PLATEN

and degree of wear. A comparison of old and new pots which were cast from the same pattern is shown in Fig. 3. If these pots were packed with small parts and placed in the same furnace together, the parts in the old pot *A* would show a considerable more case than those run in the new pot *B*, due to the more rapid heating of the old pot and its contents.

The packing operation has probably received less thought and attention than any detail that enters into our heat-treatment practice. Somehow it seems that it is such a homely task that even the efficiency engineer overlooks it, and few have tried to uplift and give it its proper supervision and place.

Every detail of the packing operation should be standardized. In a general sense, this means the gathering into a suitable index system all data as to pot sizes, the contents, the various grades and sizes of carburizing material, and special methods of packing particular parts. The packing room should be well equipped with suitable work benches, chairs and the small tools necessary to the packing operation. All of these little details carefully looked into will help provide good working conditions, which go a long way toward overcoming work variance due to carelessness.

In standardizing packing methods to prevent excessive production waste, many ingenious schemes may be

FIG. 5. CORRUGATED PLATES USED FOR SPACING WORK IN POTS

devised which will insure, even, rapid spacing of the work in the pots. Along this line, the writer has designed and used the magnetic packing platen, Fig. 4, and the corrugated plates, Fig. 5, which he has already described in detail on page 679, Vol. 50.

Exposure of the top layer of work to the destructive fire action of the furnace, due to a shrinking of the compound in the pots, is a common cause of soft, spotted and badly scaled parts. This may be prevented by covering the top layer of work with a generous blanket of compound. As a check, some plants require each packer to mark his individual clock number, in chalk, on the pots packed. Ordinary chalk will withstand the firing action and show the markings clearly after the pot has cooled. In this way packing errors are placed.

It is a good plan to thoroughly explain the whole theory of the carburizing process to every worker in the department, taking special care to impress upon each one his particular part in producing a finished piece of work that will be a credit to the united efforts of the department.

While no method of sealing has been devised which is positive and will prevent gases from leaking from the pots at carburizing temperature, this loss may be kept at a minimum by sealing the pots as shown in Fig. 6. These pots have been sealed by first buttering around the edges of the pots very liberally with a luting made of ten parts fireclay and one part salt, after which

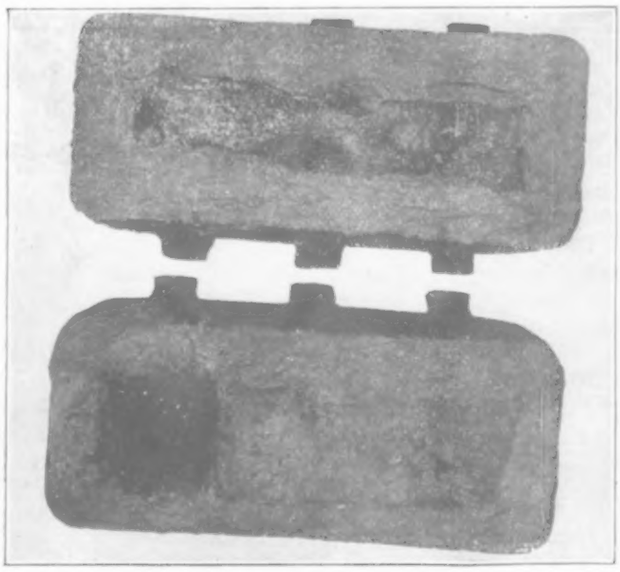


FIG. 6. SEALING THE POTS

a steel lid ¼ in. thick is pressed firmly into the luting; this in turn is thoroughly sealed by spreading another coating of the luting on top of the lid. A portion of the lid of one pot has been cut to show the buttering idea.

This simple operation often has much to do with the subject of uniformity. For example, if the pots are crowded into the furnace too closely, there will be a very uneven heating of its contents. Good furnace operators try to avoid this and are careful to space the pots evenly on the furnace floor leaving a space of at least 2 in. all around the pot for heat circulation. Loading too close to a badly fitting door will be liable to hold back the heating of the front end of the pots to such an extent that the work will be ruined. The operator should insist that the pots come to him well packed and carefully sealed, and then he should in turn give his best attention to the careful loading of the furnace

The firing of the furnace is probably the most important part of the whole process. A steady even heat should be maintained throughout the furnace. The flame should be neutral or slightly rich in gas or oil. This will prevent scaling, if the work is placed in the open fire, and it is the most economical method of firing.

Oscillation of temperature is a subject that deserves serious consideration by the furnace operator. When the heat is allowed to swing back and forth through a range of several hundred degrees, the steel is being constantly shunted back and forth through its critical range and the resultant condition is a coarse granular structure with the carbon in segregation. To avoid this, the fuel- and air-pressure lines should be of generous dimensions. The fuel and air system should be in duplicate as a matter of safety in case one of the blowers or pumps should fail.

It is by the act of quenching that the carbon which has penetrated the steel during the carburizing heat is trapped and the work hardened. The most important thing to be considered in the quenching is an even distribution of the parts quenched in a liberal supply of the quenching medium kept at a constant temperature.

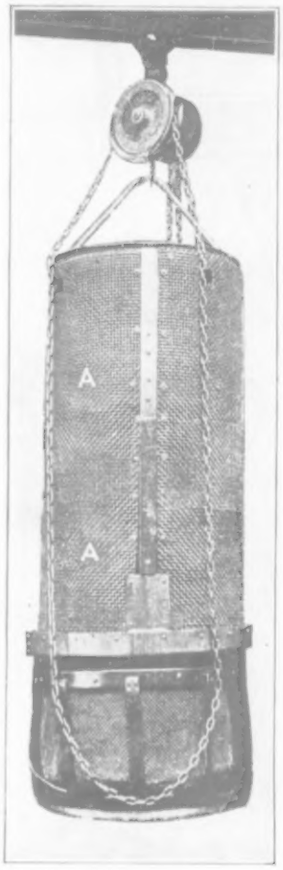


FIG. 7. A QUENCHING BASKET

This is well illustrated by the quenching basket, Fig. 7, which is shown hoisted out of the quenching tank, Fig. 8. Note the distributor cones *A*, Fig. 7, which permit the rapid and effectual distribution of the heated mass of the work throughout the basket. The baskets, being perforated, allow a constant flow of water or oil through their contents. It will be seen that the large quenching tank is supplied with ample pipe connections to supply an ample flow over the dam which is located in one end of the tank.

Every fall and winter sees a recurrence of quenching troubles in many plants, due to the falling temperature of the water used. It would be very interesting to many, I am sure, if they would carry on a systematic study of the effect of a range of 50 to 100 deg. F. in their quenching liquids. Many up-to-date plants specify the quenching temperature within a range of 20 deg.

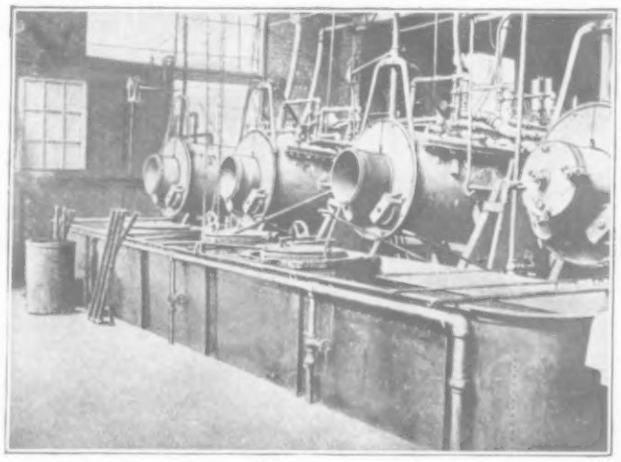
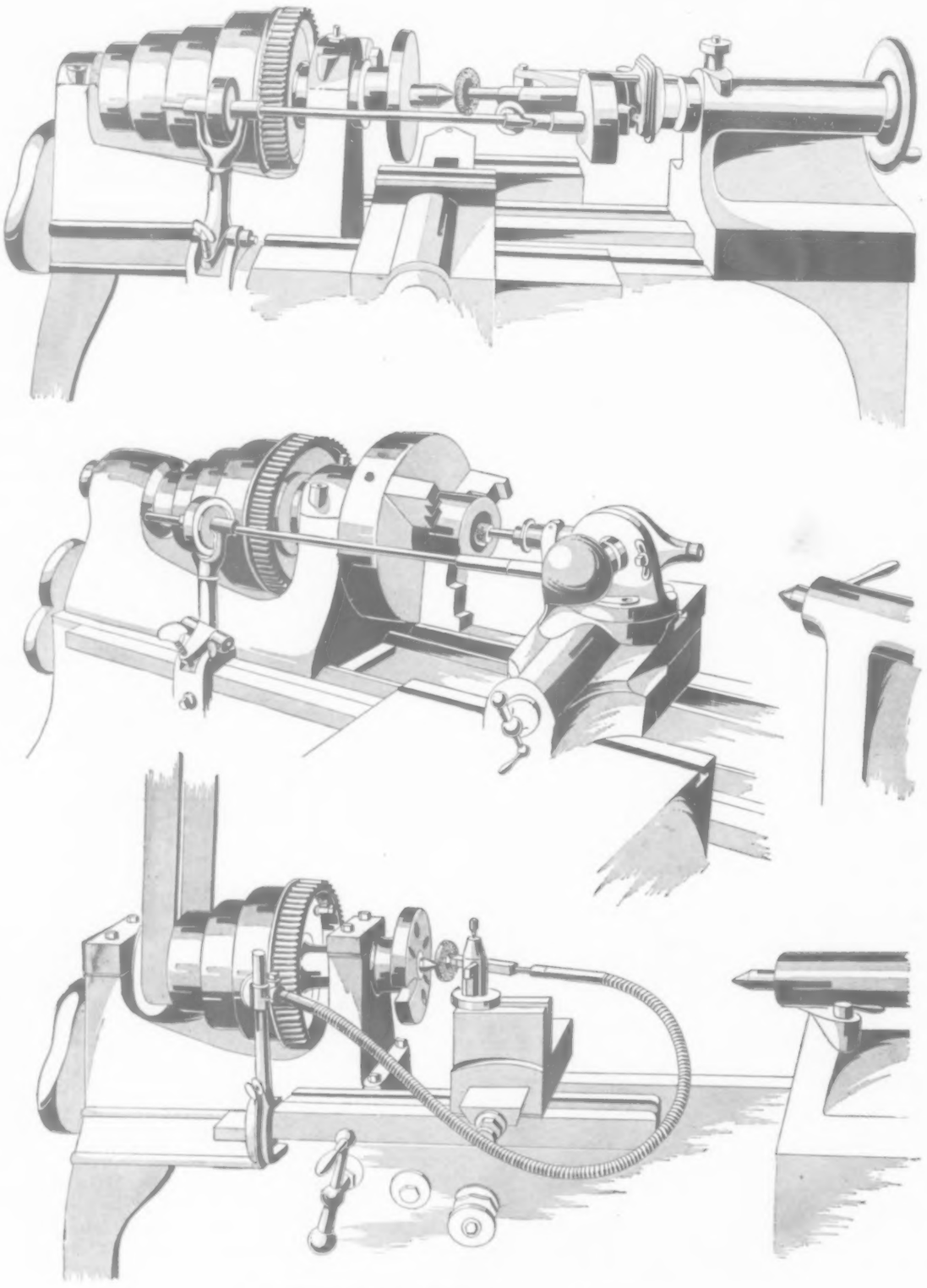


FIG. 8. A QUENCHING TANK

FOR SMALL SHOPS *and* ALL SHOPS

By J. A. Lucas



METHODS OF GRINDING IN A LATHE

Research Work on Malleable Iron*

BY ENRIQUE TOUCEDA

The value of industrial research intelligently applied is proved by the results tabulated and described in this paper. The benefits to be obtained by the coöperation of manufacturers engaged in the same line of work are also indicated. The reliability of malleable cast iron as made at the present time is a matter of considerable importance to machinery builders and figures showing the development of this characteristic are included.

IT is the writer's belief that three factors mainly operate to darken the vision of many of the manufacturers regarding the value of research work. The first is fundamental. Stated brutally, it is ignorance as to its possibilities. Following this regrettable fact is their obsession to the thought that the prime and essential requisite for success lies in the advertisement, with oftentimes the accent on the last four words. The third factor has reference to the extent to which research has been discredited through the employment for that purpose of men not qualified through temperament, proper training or resourcefulness, to undertake such work—the square peg in the round hole, the neophyte, and at times the quack. While the revelations born of the world's war have in large measure done much to open the drowsy eyes of the manufacturers, it is nevertheless certain that hard and diligent work still remains to be done before the majority will be aroused from their lethargy.

Prior to the time four years ago that research work was undertaken in the interests of the American Malleable Castings Association, the industry was in a more or less chaotic condition. There had been at least three years of serious business depression, ruinous competition as a consequence had been running its insensate course, but back of and beyond all this, was the damning accusation of the engineer, that the material, except in the case of a limited number of concerns, was not only lacking in dependability, but of low strength when dependable. In railway-car fabrication particularly, the number of malleable-iron castings used had dwindled from a very large quantity per car, to an almost insignificant number consisting mainly of unimportant details. Malleable cast iron was rapidly being replaced by the steel casting, and in other directions as well the latter was encroaching on the legitimate field of the former, and incidentally placing it in an exaggeratedly false position, for the reason that when substitutions were made the patterns were redesigned and made much heavier to accommodate the less-fluid casting properties of that metal. When a steel casting failed, the attitude taken by the engineer was that the maker did not understand his business, that he was incompetent.

FIG. 1. TESTING MACHINE DEVELOPED FOR DETERMINING RELATIVE TOUGHNESS AND DUCTILITY

If, on the other hand, the broken casting proved to be made of malleable iron, the assumption in that case was not that the maker was incompetent, but that the material, *per se*, was unsuitable for the part. Under those rather distressing circumstances it was not strange that the malleable-iron founder stopped, looked and listened. He began to awaken to the fact that recklessly he had been traveling a perilous course for a great many years, unmindful, too, of the frequent flashing of the danger signals. He was finally beginning to experience deep misgivings as to the future welfare of his industry.

It may prove pertinent at this point to make some remarks in connection with the literature of the art at this particular period. Aside from a few fragmentary articles, there existed none that contained any real information of value to the metallurgist who sought knowledge in this field, while much of it was replete with gross misinformation. It consisted for the most part of what might be called metallurgical platitudes, information at the finger ends of any well-informed metallurgist. Some very prolific writers on the subject of black-heart malleable iron can certainly be accused of considerable recklessness, which is about the mildest form in which this statement can be made, for even the most superficial chemical or metallographical investigation could have demonstrated the falsity of many of their statements. In this way, many fallacies had been handed down from one writer to another and accepted as true by those who lacked the time, opportunity or equipment to investigate for themselves.

Actually, there exist but few facts that have been solved to date in connection with the metallurgy of malleable iron that could not through careful investigation be ascertained by any competent and resourceful iron and steel metallurgist, well equipped for such a purpose. It is true that there are quite a number of baffling problems that have not yet been solved and that need solution, but in the main the strictly metallurgy part is now well understood.

Some conscientious writers, on the other hand, have expended considerable energy, have carried through many painstaking investigations and furnished abundant data as proof for their statements, and still, as the author will endeavor to make perfectly clear further on, their experiments

*Abstract of paper presented at the spring meeting of the American Society of Mechanical Engineers at Detroit, June, 1919.

have failed to prove helpful to the manufacturer of black-heart malleable iron, due in almost every case to one fundamental mistake. Other authors have applied to this product conclusions drawn from experiments made on white-heart malleable iron, such as used on the other side.

Formation of the Association

Among the various manufacturers of malleable-iron castings, at the time referred to, were some twenty-five who were progressive enough to understand the benefits that accompany coöperation, and that one might better have an intimate friend with whom to compete than an enemy. These had formed an association that had been in existence some ten years or more. The association had as its objectives the exchange of ideas in the direction of business economy, improved works practice, the study of proposed foundry and factory enactments, the securing of more favorable insurance rates, the study of problems relating to cost, labor, housing and sanitation, and finally the forming of friendships that are the natural outcome of frequent and close personal contact. It is to these men largely that credit should be given for the renaissance of the industry. They decided to enlarge their field of action and, irrespective of cost, determined to go the full road along the lines of metallurgical research. They determined as well that every statement made as to progress would be conservative and accompanied by data that would be incontrovertible, which course they have followed to the letter.

The preliminary part of this paper will be descriptive of the steps that were taken to bring system out of chaos, the second will deal with some metallurgical details of the malleable-iron process, and the third with the fallacies that have been handed down in the manner already indicated. The first step taken toward systematization was to make a hasty survey of the different plants. At the conclusion of the survey, papers were written by the consulting engineer in connection with matters deemed of most importance at the time to the membership, and in these recommendations were made as to suggested improvements in works practice generally. These papers were sent to the secretary, who had them printed in uniform bulletin form for distribution. In these bulletins to date a very wide field has been covered, as they contain quite complete details in regard to physical properties and tests, the metallurgy of the process, air-furnace and annealing-oven construction and practice, combustion, special investigations of difficulties encountered from time to time by the various members, and other matters too numerous to mention.

Method of Physical Testing

When the research work was started, it was found that by far the majority of the members had no system of testing the quality of their product, aside from the twisting and bending of a casting, in order to ascertain its ductility, or the bending over of test lugs attached to castings. Consequently, there was no way in which could be compared the quality of product of one member with that of another. To be candid, there was available no information of value that could be given to an engineer who might be seeking information of this character. Benjamin Walker, who at the time was vice president and general manager of the Erie Malleable Iron Co., Erie, Penn., a number of years previous to this, had devised for the purpose of testing the quality and uniformity of his product, what he called a test wedge. The wedge was 6 in. long by 1 in. wide, tapering from $\frac{1}{2}$ in. at its base to $\frac{1}{16}$ in. at its other end. His practice was to distribute a series of these wedges throughout the annealing oven, and at the conclusion of the anneal subject them to test—accomplished by holding the butt end of a wedge in a narrow-jawed tongs, placing it upright on an anvil, and striking its top end with a 6- or 8-lb. sledge. In this manner the thin end of the wedge would gradually curl up under these repeated blows, and it is apparent that the more blows the wedge would stand before fracture, the shorter would be the butt left in the jaws. The shortness of

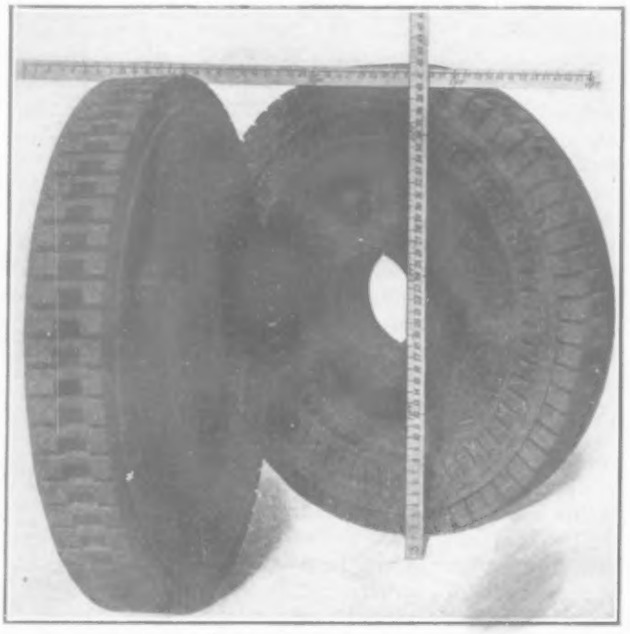


FIG. 2. EXAMPLE OF LARGE MALLEABLE-IRON CASTING

this butt he considered was a measure of the metal's ductility.

It was decided that an attempt would be made to standardize this test for adoption by the association. With this end in view a machine, Fig. 1, was so designed that a weight of 21 lb. when raised to a height of 3.33 ft. above the top of the wedge, when placed in position for test on the anvil of the machine, would be automatically tripped to deliver a fairly constant blow on the thin end of the wedge. The blows were counted, and for convenience the number delivered, before rupture took place, was recorded as the *blow efficiency* (assumed to be a measure of toughness), while the length of the butt (assumed to be a measure of ductility) was measured and expressed in terms of *butt efficiency*. These were arbitary terms, understood by the members, and intended for their use only. It will be noted that the test is one of great severity, for the reason that the first blow must be borne by a section but slightly larger than 1 in. by $\frac{1}{16}$ in., and equals, expressed in pounds of static pressure, over 1350 lb. As the wedge curls and consequently shortens, subsequent blows obviously are delivered through a slightly greater distance, while, as the wedge must be held in such a position that it will be hit squarely and not upset when struck, it is evident that the blow must be delivered on the high-

est point of the curl. As this point is quite some distance away from the center of the section that resists the blow, it is obvious that the effect of the blow is augmented by the horizontal distance of this point from the center of that section whose bending moment is the greatest. Twenty blows have arbitrarily been chosen to correspond to a blow efficiency of 100 per cent., but at the present time we have numerous members whose wedges invariably test better than 30 blows. When a wedge fails to break at 30 blows without fracture, it is thrown aside, as it is obviously a waste of time to investigate it further.

It was decided that tensile-test bars should be cast by all of the members, and further that they be required to send to the consulting engineer one tensile-test bar and one test wedge from some one heat of each day's run. This made possible the ascertainment, not only of the quality of each member's product, but furnished

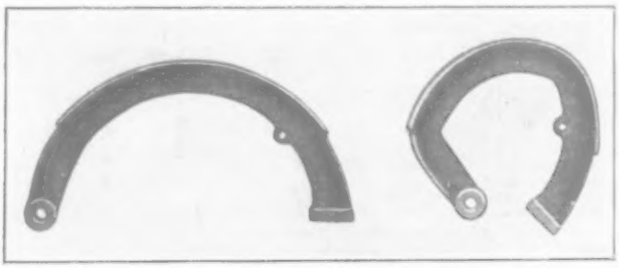


FIG. 3. EXAMPLE OF ABUSE MALLEABLE CASTINGS WILL STAND

data through which a comparison could be made of the quality of the product of the membership as a whole. Equally important, it also served as a direct and positive measure of the progress that ensued from month to month. The dimensions of the tensile-test bar are similar exactly to those contained in the American Society for Testing Materials, specification for malleable cast iron. It is a round bar 12 in. long. The ends that go in the grips are each 3 in. long by $\frac{3}{4}$ in. in diameter, and gradually taper in a distance of 1 in. to the reduced section, which is $\frac{5}{8}$ in. in diameter and 4 in. long. At the end of each month a report is made of the results of the tests. This report is promptly printed and distributed in the form of a bulletin. For convenience, and in order that the situation can be easily analyzed, the results are classified and tabulated as follows:

Per cent. of bars having an ultimate strength lower than	40,000 lb.
Per cent. of bars having an ultimate strength falling between	40,000 and 42,000 lb.
	42,000 and 44,000 lb.
	44,000 and 46,000 lb.
	46,000 and 48,000 lb.
	48,000 and 50,000 lb.
	50,000 and 52,000 lb.
Per cent. of bars having an ultimate strength over	52,000 lb.

The average elongation of each class is recorded under the figures for ultimate strength in that class. Accompanying the foregoing, but not reproduced here, is a tabulated record of the results of each member's work. The members are classified into those who make railway work, and those who do not. To the former is assigned a letter, and to the latter a number. Through this procedure, each member can identify his record but not that of any other member, as all of the identification marks are known only to the consulting engineer.

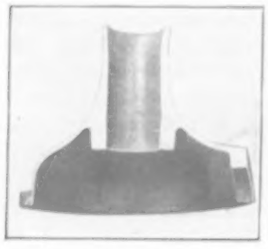
In this manner it is possible to learn just how each member is progressing, and if it is considered by the research committee that his progress has not been as rapid as it should have been, the consulting engineer is requested to pay him a visit with the object of aiding him more quickly to better his condition.

It is pertinent at this point to present in as fair and impartial a manner as possible a comparison of the physical properties of malleable iron manufactured within the last few years with that made in the period prior to 1913. Before entering into this matter, the writer wishes to go on record as stating that any data in connection with the ultimate strength of malleable iron is valueless so far as serving to show its real worth, unless accompanied by information regarding the ductility of the metal as measured by the elongation. If one knows how, there is no difficulty whatever in uniformly making a metal of 85,000 lb. ultimate strength, provided ductility be sacrificed down to what would be represented by a 5 per cent. elongation. Further on the structure of such material is shown. In the past there have been occasional records of tests that have run somewhat similar to these figures, and such tests have been quoted by others in different articles, but in the light of present practice this is not considered good malleable iron, unless it is to be used for special purposes where ductility is not of consequence and a high ultimate strength is imperative. When such high ultimates were obtained it must obviously have been by accident rather than design, because if 5 per cent. elongation was a rather high average at the time, it follows that it would have been accompanied by a high ultimate strength had it been known how to obtain it. There are still stronger reasons for making this statement. For many years the writer has had an unusual opportunity to learn either at first hand or on good authority what character of product most of the concerns made, and aside from one concern which had always enjoyed an enviable reputation for the uniformity and excellence of its product and another very large company whose plants were very painstaking in their methods of manufacture, the ordinary run of malleable iron was undoubtedly inferior. The record of tests made in this laboratory during the period mentioned do not exceed three hundred. They do, however, represent the product of many different concerns. As some of the bars were of square section, some rectangular, and others round, it is plain that no uniformity existed in their dimensions. The latter vary anywhere from $\frac{1}{2}$ to 1 in. in diameter, while the former for the most part are 1 in. square and 1 in. by $\frac{1}{2}$ in. The great majority of these tests show that the ultimate strength was under 39,000 lb. per square inch, while the elongations were for the most part under 3.5 per cent. There are instances of fairly high strength, slightly over 48,000 lb., while the highest elongations, ran 7 per cent. in 4 inches.

It happens that the writer has a record of tests made in 1911 on bars made by seven concerns that were deemed at the time to be unquestionably among the very best producers of malleable-iron castings. These founders were each asked to make 20 of the very best bars they could produce for test, 10 to be 1 in. in diameter, and 10 to be $\frac{1}{2}$ in. in diameter. In these tests the average ultimate strength of the 70 bars 1 in. in diameter is 39,882 lb., and the average elongation exactly 5 per cent. The lowest ultimate is 31,990 lb. and the highest 45,560 lb., the lowest elongation 1.7 and the highest 9.8 per cent. In the $\frac{1}{2}$-in. bars, the average ultimate is 41,693 lb. and the average elongation is 5.5 per cent. The lowest ultimate is

33,600 lb. and the highest 47,430 lb., lowest elongation 1.2 and highest 6.3 per cent. Inasmuch as each of these seven concerns were informed that what was wanted was 20 test bars that would represent the very best product they could make, and inasmuch as these manufacturers were considered among the best of the producers, it would appear that the writer is warranted in assuming that the foregoing tests would represent a high rather than a low average.

Table I is reproduced from Dr. H. M. Howe's book, "The Metallography of Steel and Cast Iron," pp. 96 and 97. In the first series of this table there is a very good bar, though the writer is inclined to doubt the accuracy of the figures under the elastic limit column. In the second there is a bar, slightly better than the other. The one with 8.2 per cent. elongation is also good. The second series furnishes a guide as to what was deemed to be unusually good malleable iron several years ago.



FIGS. 4 AND 5. EXAMPLES OF CASTING OF DISPROPORTIONATE SECTIONS

TABLE I. PROPERTIES OF MALLEABLE CAST IRON (H. M. HOWE)

		Tensile Strength, Lb. per Sq.In.	Yield Point, Lb. per Sq.In.	Elongation Per Cent. Inches	Contraction of Area, Per Cent.
Malleable Castings. Standard Properties					
E. Schoemann. Openhearth furnace		44,230	.....	3.9 ..	.....
		48,640	.....	4.5 ..	.....
W. P. Putman		39,638	28,326	7.03 2	10.52
		50,849	41,792	10.15 ..	20.92
Kent, Master Car Builders' Association, 1891 Size of specimen	1.52x0.25 in.	34,700	21,100	2.0 4	.....
	2.0 x0.78 in.	25,100	15,400	1.5 4	.....
	1.54x0.88 in.	33,600	19,300	1.5 4	.....
	1.52x1.54 in.	28,200	.....	1.5 4	.....
Kent		32,000	.....	2.0 4	.....
Toueda. Avg. strength of commercial		41,000	.....	....	.....
Malleable castings. Unsually good properties.					
C. H. Gale		60,000	.....	....	.....
		70,000	.....	....	.....
H. R. Stanford average of	3 tests ½ in. diam.	55,100	.....	5.2 ..	5.5
	3 tests ½ in. diam.	64,500	.....	2.8 ..	1.3
	2 tests ½ in. diam.	69,100	.....	4.0 ..	2.6
	2 tests ½ in. diam.	56,700	.....	8.2 ..	8.4
	3 tests ½ in. diam.	51,600	.....	7.0 ..	7.7
	42 tests ½ in. diam.	49,810	.....	6.61 ..	6.23
S. B. Chadsey		45,810	.....	6.25 4	.....
		55,230	.....	10.25 ..	.....

Fallacious Theories of Malleable Iron

In "Hatfield's Cast Iron in the Light of Recent Research," 1912, page 213, is a table containing the results of 14 tensile tests of bars 1 in. by ⅜ in. in section. The bars run uniformly and the material, while of low strength, is ductile. The latter should certainly be expected in bars that are but ⅜ in. thick. The lowest ultimate strength is 38,820 lb. and the highest 45,700 lb., the lowest elongation 10 per cent. and the highest 15.3 per cent. Under this table appears the following: "If attempts are made to increase the maximum stress obtained from such iron, the elongation would appear to have to be sacrificed, and to a considerable degree. The cause of the increase in tonnage is the retention of increasing proportions of combined carbon. This combined carbon stiffens the material and incidentally reduces its ductility." The writer believes that he was the first to prove and furnish indisputable evidence as to the falsity of the statement that the ductility of malleable iron decreased as its ultimate strength increased. While Hatfield is correct in assuming that the ultimate strength is increased and the ductility decreased with an increase in combined carbon, the statements indicate clearly that he was, at the time at least, not familiar with the manner in which malleable iron can be obtained having the characteristics of high strength accompanied by high ductility. It can be stated that in normal malleable iron as made today, the higher the strength the higher will be the ductility, and in this particular this metal is unique. In a paper read by Dr. Richard Moldenke, before the American Foundrymen's Association, in 1903, can be found these words: "The tensile strength of malleable castings should run between 42,000 and 47,000 lb. per square inch; castings showing only 35,000 lb. are serviceable for ordinary work. It is *not advisable to run beyond* 54,000 lb. per square inch *for the resilience is reduced*, and one of the valuable properties of the malleable casting impaired. The elongation of a piece of good malleable will lie between 2½ and 5½ per cent." In the "Mechanical Engineers' Handbook," edited by Prof. Lionel S. Marks and published as late as 1916, appears the following by the same author: "These castings *should not be machined*, as the interior is not as strong as the metal at and near the surface. Tensile strength 35,000 to 48,000 lb. per square inch. European malleable cast iron, made by a somewhat different process, is not as sensitive to machining, the castings which are thin only, are practically decarbonized in the annealing process, whereas in the American blackheart malleable iron only the skin is decarbonized, the metal adjacent for about ¼ in. partly so, and the central portions contain the full carbon percentage of the original hard white casting." The writer has italicized certain parts of the matter quoted in order to devote if possible a little attention to these parts later on. It is believed that the foregoing fairly sets forth the state of affairs as to physical properties during the period mentioned.

Improved Physical Properties Due to Research

Let us see what improvements have been made within recent years; that is, since the research work was started for the association. We will not select the best month's record, but will reproduce in part the very last report sent to the members; that is, the record for March, 1919.

Table II covers the physical tests for ultimate strength and elongation on bars received during the month of March, 1919. It would be impossible, almost, to consider the figures in this record and fail to note that as the tensile strength increases, so does the elongation. These monthly records have been kept in this manner for four years or over and there is no exception to this rule. It will be noted that only 0.40 per cent. of the total bars received tested under 40,000 lb. per square inch. As a matter of fact, only 10.54 per cent. were under 46,000 lb., while 44.06 per cent. stood over 52,000 lb. with an average elongation of 14.67 per cent. The best individual record showed an average of 59,681 lb. ultimate and 21.47 per cent. elongation. The worst was 39,942 lb. ultimate and 4.20 per cent. elongation. The

latter record belongs to a member who but very recently joined the association, and bears out quite well the thought that the writer has been endeavoring to convey.

The members who submitted bars classified under "railway work" were 22 in number. The average ultimate strength and elongation of test bars submitted by the 11 members having the highest averages are found to be 53,559 lb. and 15.56 per cent., respectively. Carrying through the same operation with the 26 members who are not thus classified, it is found that the average ultimate strength and elongation of these 13 are respectively 52,327 lb. and 12.42 per cent. Taking the average of these 24 members, we find that the ultimate strength is 52,943 lb. and the elongation is 13.99 or practically 14 per cent. Lest our intention be misunderstood, it should be explained that our effort is not directed toward securing an increased ultimate strength and elongation so much as uniformity of product. The aim is to secure a product that the engineer will readily acknowledge possesses excellent physical properties, which vary but little from heat to heat. Within what

TABLE II. ANALYTICAL EXAMINATION OF PHYSICAL TESTS FOR ULTIMATE STRENGTH AND ELONGATION ON TEST BARS SUBMITTED DURING MARCH, 1919

Limits of Ultimate Strength	Per Cent. of Bars	Per Cent. Elongation
Under 40,000 lb.	0.40	4.50
Between 40,000 and 42,000 lb.	0.88	6.86
Between 42,000 and 44,000 lb.	2.79	7.67
Between 44,000 and 46,000 lb.	6.47	8.13
Between 46,000 and 48,000 lb.	10.29	9.50
Between 48,000 and 50,000 lb.	17.16	10.09
Between 50,000 and 52,000 lb.	17.95	11.55
Over 52,000 lb.	44.06	14.67

can be considered quite narrow limits, this is what these particular 24 members are doing, while most of the others are not far behind. It may also be of interest to state that from Jan. 1, 1917, to Mar. 31, 1919, the average ultimate strength of the test bars of the association as a whole has been over 51,000 lb. ultimate and the elongation 12.50 per cent.

Influence of War Conditions

In considering the last statement the following facts should be taken into account. War conditions during 1917 and 1918 made it quite impossible to secure appropriate pig iron and fuel. It is only fair to state that most of the companies were greatly handicapped during this period. It was solely and only through an intimate knowledge of the metallurgy of the process derived from the research work that made such a showing possible. Aside from this the membership has been and is constantly growing and the total average is, and for some time to come will be, necessarily affected as a consequence, as it takes some few months to get a new member in line. It is unfair to assume that a still better showing could have been made had the times been normal, and had the membership been confined to those only who were members when the research work was first started. At the beginning of our investigations an elongation of 10 per cent. was considered to be an indication of a superior product. As our knowledge of the metallurgy of the process increased, accompanied by better air-furnace practice and annealing-oven conditions, the elongation particularly began to climb. An elongation of 20 per cent. is not now looked upon as unusual; elongations of 25 per cent. occur with considerable frequency, while we have had numerous bars that have run as high as 30 per cent. and several of 31 per cent., which for an untreated cast-iron product we believe to be quite extraordinary.

For the benefit of those who labor under the impression that malleable iron is a product unsuited for any but small castings, Fig. 2 is shown. One casting of which the writer has a photograph is 5 ft. long, 23 in. high and some of its sections are 3 in. thick. That the metal, when well made, can stand great abuse is illustrated in Fig. 3; while the problem in regard to disproportionate sections that confronts the manufacturer, coupled with intricacy of design, and too often the intricacy of ill design, is well illustrated in Figs. 4 and 5. Irrespective of how good the metal may be, as shown by physical tests on bars and wedges, patterns are furnished so outrageously out of proportion that the good qualities of the metal can easily be destroyed and too frequently the metal is blamed when the design is at fault. These troubles are overcome as far as possible by a thorough study of the best method of gating the casting, in order that no evidence of shrink will be present in any part. Research has made considerable advance in this direction and well-placed, well-proportioned shrink heads are now generally used. Not infrequently, in the case of such castings as the ones referred to, the sprue, runners and heads weigh about as much as the casting.

Common Fallacies

Before taking up the matter of fallacies, which during the past few years have been pretty well exploded, although some still linger in the minds of a few of the engineers and consumers, the writer would like to make some further remarks by way of explanation concerning what was stated in the first part of this paper in connection with the literature of the subject. Enough has been shown to make clear the fact that in order to make a good quality of malleable iron, it is absolutely necessary that the white-iron-casting composition be correct. Many very interesting and laborious researches have been made in connection with the precipitation of the carbon during the anneal and in numerous other directions on hard-iron samples whose physical properties would be so low as to be worthless when annealed, due to their impossible composition. Had the same work been done by the eminent men who have carried through the experiments referred to on a hard-iron composition that was normal in all particulars except in connection with the particular element they were investigating, the metallurgist in this particular field would have been greatly benefited and his path made easier.

The fallacies that have been handed down and accepted by many of the engineers and consumers as true, are numerous, but the following only will be touched upon as they are the most important:

(a) The strength of malleable iron lies in the skin. When it has been removed the remainder of the metal is found to be very inferior and not dependable.

(b) During the anneal, the elimination of the carbon is confined to the surface, and the amount removed from the rest of the section is inconsequential.

(c) When the section of a casting exceeds $\frac{5}{8}$ in. in thickness, it cannot be annealed throughout.

Concerning item (a), the data in Table III will prove of value. Nine regular test bars were machined until

the decarbonized surface was removed. These bars were all from different heats and marked as indicated in the table.

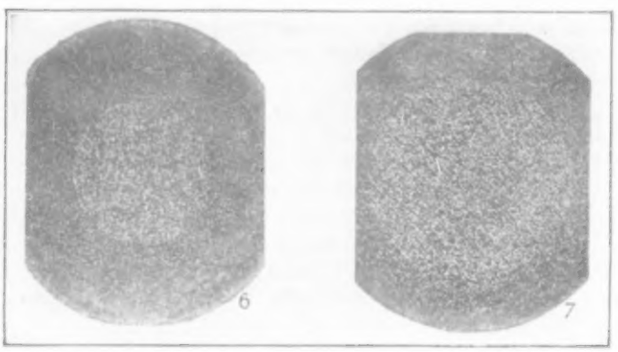
As the writer did not have duplicates of these bars, he was unable to make a comparison between the machined and the bars as cast and lacked time to run through a set for illustration, but the experiment should be unnecessary in any event in view of the above. It is obvious and must be acknowledged that the metal in the decarbonized skin is more ductile than the core, so when a bar fails it must be conceded that it is the core that has parted first, for the reason that the metal in the skin has not at the instant of fracture reached its maximum elongation. Aside from the foregoing we have the practical evidence that presents itself in the case of the automobile industry in which thousands of tons of machined malleable-iron castings are used annually on parts that receive in service great

TABLE III. TESTS OF MALLEABLE-IRON BARS WITH DECARBONIZED SKIN REMOVED

Mark	Ultimate Strength, Lb. per Sq.In.	Per Cent. Elongation in 2 In.
12-2-1	52,084	17 50
12-3-1	47,182	10 00
12-3-2	51,107	17 50
12-4-1	56,732	14 00
12-5-1	46,482	7 00
12-5-2	52,246	23 00
12-6-1	47,889	19 00
12-7-1	48,080	18 00
12-7-2	49,640	18 00

abuse, such as wheel spindles, etc. On the other hand, the writer not only admits that when the skin is machined off some malleable-iron castings the remaining part is worthless, but admits as well that the castings would be such with the skin on. This, unfortunately, will continue to be the case until the purchasing agents cease to shop around and make contracts with price as the basis rather than quality.

Taking up item (b), the writer can, without encumbering this paper with the large amount of data he has on the subject, prove the falsity of this contention. In the analysis of a series of test bars which showed over 52,000 lb. ultimate strength and over 20 per cent. elongation, there were two bars, one of which had a carbon content of 0.72 per cent. and the other of 0.82 per cent. Aside from this there were 14 with a carbon content of 1.50 and under. It has already been pointed out that the carbon in the hard iron must be kept up to a certain figure, failing which the castings will not only misrun but contraction cracks will spoil them. If we assume, in the case of the first two bars referred to, that the carbon was reduced by one-half, then in the bar that had but 0.72 per cent. carbon, the carbon in the hard iron from which it was cast must have been 1.44 per cent., and we all know that it would be almost impossible to run such work, to say nothing about subsequently annealing it. In a ⅝-in. diameter annealed bar such a low carbon content is unusual, but it proves the point that is being made, nevertheless. The writer has polished the section of two ⅝-in. bars and has photographed them at about seven diameters. These are shown in Figs. 6 and 7. They will furnish a fairly good idea as to how the carbon is distributed throughout the section, and indicate that the carbon does not vary by uniform gradation from surface to center, but in one region can vary slightly from what it may be in another. This does not signify that in the regions of highest carbon content the carbon has not been lowered through diffusion into its contiguous region, for many investigations have shown that this is just what does happen.



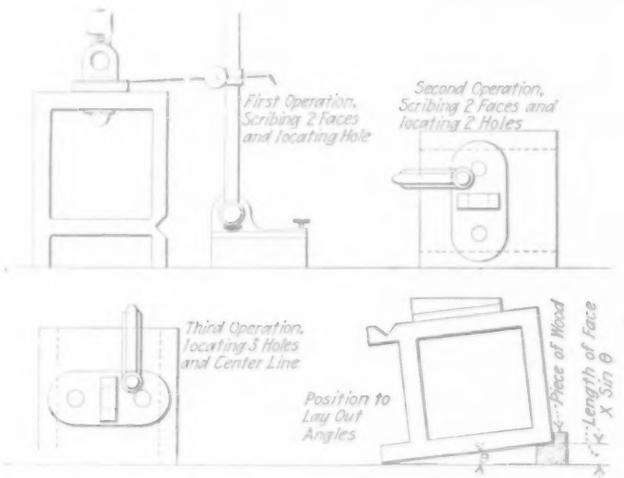
FIGS. 6 AND 7. BARS MAGNIFIED SEVEN DIAMETERS TO SHOW CARBON DISTRIBUTION

Item (c) can be disproved in a few words. We know that in order to break up the hard carbide in white iron it is simply necessary that the casting be not only heated until the iron is in an austenitic condition, but maintained at that temperature for a certain interval of time. To state that thick castings of white iron cannot be annealed is to state that they cannot be brought to a uniform temperature throughout and maintained at that temperature. Such a claim would be an absurdity.

A Lay-Out Block

BY M. J. WACLAW

In large machine shops where any considerable amount of layout work is done, angle plates are frequently used. The sketch represents a simple and efficient fixture which is more adaptable than the ordinary angle plate, and which consists of a hollow casting with


First Operation, Scribing 2 Faces and Locating Hole
Second Operation, Scribing 2 Faces and Locating 2 Holes
Third Operation, Locating 3 Holes and Center Line
Position to Lay Out Angles
Length of Face × Sin θ
Piece of Wood

A HANDY LAY-OUT BLOCK

walls about 1 in. thick and all faces planed square and parallel. A groove may be cut across one face to hold cylindrical objects.

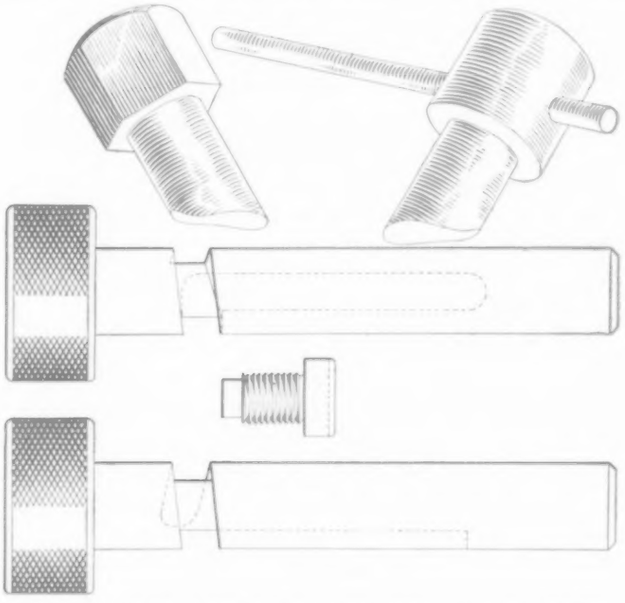
Work to be laid out can be clamped to the block by C-clamps and the layout completed in one setting; all lines parallel and at right angles may be drawn with a surface gage by setting the block on a surface plate on corresponding faces.

Angles, taper, bevels, etc., can be obtained by tilting the block the desired amount.

A Quick-Operating Jig Screw

By G. O. Freeman

The accompanying sketch illustrates a quick-operating screw that can be used to hold work in jigs and fixtures. One twist of the wrist and a pull back will release the work and the reverse of this will clamp it.



A QUICK-OPERATING SCREW FOR JIGS AND FIXTURES

If the work requires much pressure to hold it, the end of the screw can be squared to fit a wrench or handle, or a hole can be drilled through it and a rod inserted.

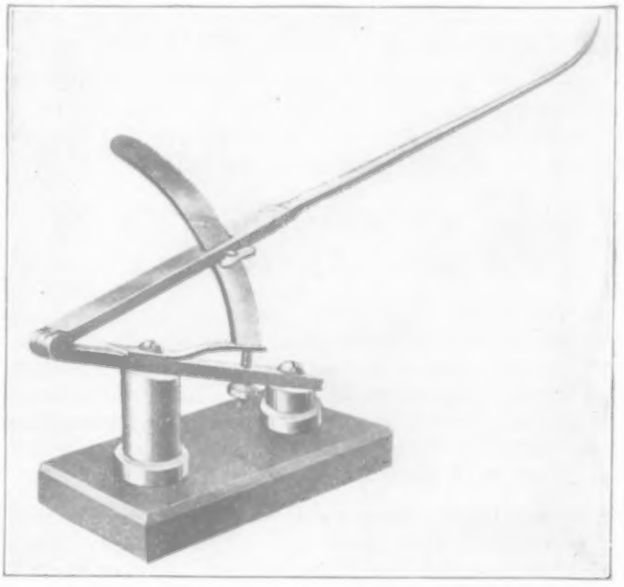
Necessity Is the Mother of Invention

By L. M. Manley

It has been truthfully said that necessity is the mother of invention, and it is only necessary to look at the commonplace things about us for evidence of this statement. Have you ever noticed some improvised tool in a shop and wondered what motive prompted its being? The mystery of it all is most fascinating.

Only last week I was taking advantage of the protection offered by an hospitable awning from an afternoon shower. The awning belonged to a typical pawnshop, in whose windows was the most cosmopolitan collection of tools I ever saw. In one corner of the window I noticed an odd-looking tool which I finally made out as a homemade surface gage. And then I wondered who the maker was and what the circumstances were that made it necessary for him to tinker around until he had hit upon the scheme which finally found itself, in material form, in a Potter's field, as it were.

The idea embodied in this ingenious device is not without merit, as an examination of the accompanying illustration will show. The device consists of a base on which are mounted two posts. To these posts is fixed a wing divider, with the spring leg cut off as shown. The operation of the gage is apparent.



A HOMEMADE SURFACE GAGE

Another Micrometer Height Gage

By John Nevins

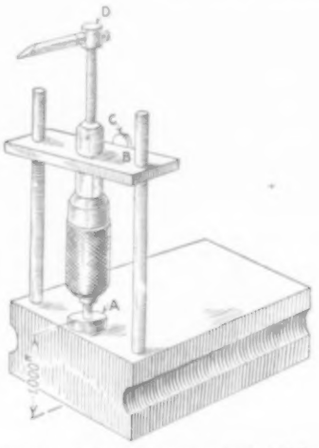
The accompanying sketch illustrates the way in which I made a height gage, using a regular inside micrometer for the measuring feature.

The base of the tool is of steel, pack-hardened, ground and carefully lapped so that the measurement over the top of the button *A* is exactly one inch. The smaller parts are all made of tool steel, hardened and lapped to fit. The button *A* and the uprights are a press fit in the base, while the cross-piece *B* slides freely without shake on the rods. The hole in the center of the slide is a push fit for the barrel of the micrometer.

It was necessary to make a small knurled-head screw *C* to take the place of one of those that are put in the barrel of the micrometer by the maker of the latter.

This screw serves to hold the slide *B* in place and prevents the barrel from turning. The slide, of course, moves up and down on the rods as the thimble of the micrometer is turned.

A head *D* is made to go on the end of the measuring stud or extension rods. This head carries a scriber



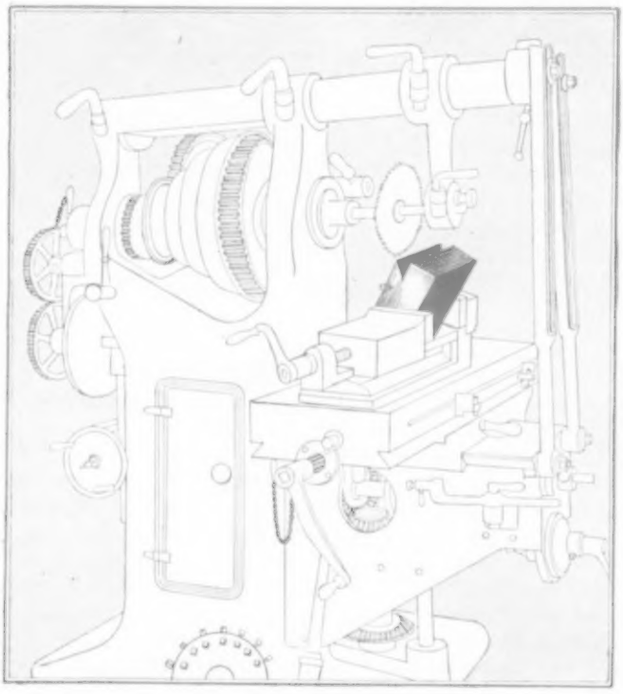
IMPROVISED MICROMETER HEIGHT GAGE

in such position that the point is in exactly the same plane as the upper end of the rod to which the head is at the moment attached, thus enabling the tool to be used as a positive measuring instrument.

Relieving a Dovetail So It May Be Scraped by Hand

By Oscar Craft

Grind a $\frac{1}{8}$- or $\frac{3}{32}$-in. metal-slitting saw to 60 deg. until its teeth come to a point and bring it into contact with the work as shown in the cut. Raise the milling-machine table straight up until the cutter touches the work, then give 10 or 15 thousandths more raise, which will relieve both surfaces.

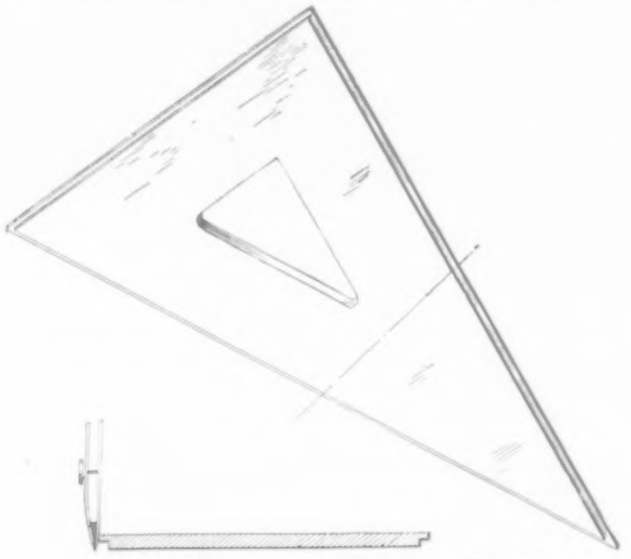


RELIEVING A DOVETAIL

A Non-Blotting Triangle

By C. H. Berry

I have seen a number of articles lately on the use of triangles in such a way as to avoid blotting freshly inked lines, but none of them seemed to be just the



TRIANGLE FIXED TO PREVENT BLOTTING

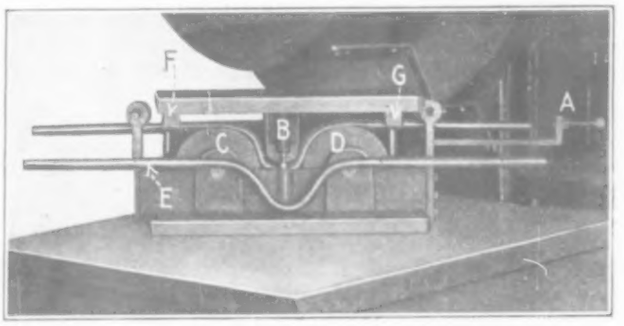
thing. Here is one that I have used with a considerable degree of satisfaction.

A rabbet, about one-half the thickness of the triangle and $\frac{1}{8}$ in. or so in depth is cut all the way around the edge and it is used with the undercut side next to the paper as shown in the sketch.

Using Rollers in a Bending Fixture

By I. B. Rich

The autocar brake shaft has a U-bend in the center and after trying different methods of producing this rapidly and satisfactorily, the bending fixture shown in the illustration for bending the rod cold has been adopted. The end of the straight rod is placed against the stop *A*, while lying across the two rollers. Then the plunger *B* is placed in the guide plate, and a single



FIXTURE FOR FORMING U-BEND

downward movement of the ram of a large punching machine forces the plunger down, draws the rod over the two rollers *C* and *D* and gives it the form shown at *E*. The ends of the rod are held against bending and in their proper position by means of the guides *F* and *G*. The use of the rollers makes this an easy and satisfactory operation.

EDITORIALS

An Announcement to Our Readers

THE editor would like to write to each one of you and thank you personally for the gratifying support that you have given us during our fight with the radical printing unions. Despite the fact that four issues of the *American Machinist* have been delayed on account of this trouble, we have not received one letter reproaching us for this delay from our twenty-six thousand subscribers.

Our advertisers have been equally generous with us. They have told us to go ahead and repeat their copy as often as expedient. The combined coöperation of subscribers and advertisers is of course something that we appreciate highly.

Four issues have been delayed. While we cannot say that our troubles are altogether over we are getting out of the woods and our press room and composing room look almost normal again. Two courses are open to us. One is to catch up as fast as we can with these delayed issues, bringing out an issue, say, every five days until we are again even with the calendar. The other alternative is to double up the editorial section for two issues, thus bringing the reader up to date.

This latter alternative, it is hardly necessary to say, is vastly more expensive inasmuch as we, by so doing, will omit the equivalent of two complete issues of advertising. We feel, however, that it is a matter of duty on our part to bring the reader up to date with his issues just as soon as possible, and also a duty on our part to pay the cost of this strike out of our own pockets and not pass it along to the advertiser. It is the McGraw-Hill Company's cash contribution toward sane American industrialism.

In this issue, therefore, we are publishing a double editorial section covering the 13th and 20th, with the advertising section that corresponds to one issue only. We plan to double up again in this way in the near future and then, having caught up with the calendar, hope to greet you as regularly and heartily each week in the future as we have in the past.

Law and Order in the Shop

LAW and order are the foundation of civilization and modern industry. And yet our interpretation of law and order too often depends on how it affects us as individuals. We are very apt to insist on the observance of laws and rules which prevent the other fellow from doing things which annoy us, but we are not nearly so keen when the laws affect our own habits or convenience.

Fire losses are tremendous in this country and are a direct tax on everyone, and we are endeavoring to prevent fires in shops and elsewhere by drastic rules printed in red and posted in conspicuous places. But it is hardly to be expected that the men will be deeply impressed by such notices when they are ignored by the office force. They realize that a fire started by the cigarette of a clerk or even of the manager will be just as disastrous as though it were started by a workman's pipe.

Much of this breaking of the rules comes from the idea that we must not ask a visitor to refrain from smoking while going through the plant, and to make him feel a little less guilty of ignoring the glaring signs, we accept the opportunity of indulging in a smoke without serious misgivings.

Probably very few fires are started in this way and the real danger is not so much in fires as in the effect on the men in the shop in breeding a contempt for law and order. When a body of men, particularly those from countries where the laws are very strictly enforced, see the heads of the concern smoking as they walk past a sign which says *No Smoking Under Penalty of the Law*, they can hardly be blamed for ignoring other laws in a like manner.

If it is necessary to prevent smoking in a shop or office in certain departments, there should be no hesitation in so doing. But there should be no exceptions—all should obey the law or rule. Unless this is done we can hardly expect compliance with other laws which may be vital to the welfare of a community. Cultivate respect for law in your own plant by seeing that all observe it and you have done much to assist the reign of law in the community.

French Shops Starting Up

REPORTS from a French engineer who has recently come to this country inform us that there is a decided improvement in the industrial situation in France at the present time. The epidemic of strikes and general unrest which followed the war seems to have passed off and the factories are resuming work as rapidly as the various businesses can be reorganized. Both employers and employees are realizing that production is the only thing which will put the country back on its feet.

The one thing that stands in the way of her trade with this country is the rate of exchange, which at times adds from forty to fifty per cent. to the price of everything bought here. This is very likely to force France to secure supplies of various kinds from Germany, which, on account of the rate of exchange between the franc and the mark, makes it not only advantageous but almost necessary for them to do so. There are many reasons of sentiment why this should not be done, but on the other hand it must be remembered that it is only by trading with Germany that France can be paid her war indemnity, and it is even hinted that the government is not averse to the present rate of exchange on that account.

The main thing, however, is that France is realizing how necessary production is to her success. The sooner the rest of the world takes this same lesson deeply to heart, the better for all concerned.

American Educational Institutions Offered Government Machine Tools at 15 Per Cent. of Cost

ON January 23, 1919, the *American Machinist* published an editorial entitled "The Solution of the War Tool Problem," in which we proposed that the Government's surplus war tools be made available to the educational institutions of the United States, for the furtherance of technical and industrial training.

This suggestion was taken up at once by Congress and a measure known as the Caldwell Bill H. R. 15625 was introduced in the House, providing for the loan of these tools to responsible institutions.

The Secretary of War approved of the purpose of this bill, but not of the proposal to *loan* this equipment. His office suggested an outright sale at ten per cent. of the cost price. This bill was amended to accord with the Secretary of War's suggestion.

In the Senate a similar bill was introduced, except that the sale to educational institutions was to be at twenty per cent. of the cost. Later on, conferees of the House and the Senate agreed on a figure of fifteen per cent. In the form quoted, this bill, after passing the Senate, was signed by the President on November 22, and is now a law.

The disposal of these tools will come under the jurisdiction of the Director of Sales of the Purchase, Storage and Traffic Division of the War Department. The Office of the Director of Sales is now working out the form of procedure to be taken by schools desiring equipment and this will be made public within a very few days.

> *"That the Secretary of War is authorized, under such regulations as he may prescribe, to sell at fifteen per cent. of their cost to trade, technical and public schools and universities and other recognized educational institutions, upon application in writing, such machine tools as are suitable for their use which are now owned by the United States of America and are under the control of the War Department and are not needed for Government purposes. The money realized from the sales may be used by the Secretary of War to defray expenses, except cost of transportation, incident to the distribution of the tools. The balance shall be turned into the Treasury of the United States as miscellaneous receipts; provided that in the event such material is offered for sale by said institutions without consent in writing of the Secretary of War, title thereto shall revert to the United States."*

We feel very much gratified that the *American Machinist* has had the honor of starting a movement which means so much to trade and technical education in America. We believe that the industrial skill that will be fostered during the next ten years by this Government investment in education will be a powerful factor in maintaining and extending American industrial proficiency.

Army Ordnance Association Holds Big Industrial Meeting

SOME 500 charter members of the Army Ordnance Association met at the Aberdeen Proving Ground, Md., Oct. 24 and 25, to hold the first annual meeting of the Association and to witness demonstrations of the latest type of ordnance matériel. Nearly every state in the union was represented by members present who met for the purpose of initiating the movement that is intended to keep America industrially prepared, and avoid the repetition of difficulties that were encountered in our last war in getting the production program under way.

The meeting occupied the whole of Friday and Saturday morning, members being cared for Friday night in the Government barracks and meals being served at the Aberdeen mess. On Friday night an interesting vaudeville entertainment was provided at the Y. M. C. A. hut.

At the business meeting which took place Friday afternoon in the Administration Building at Aberdeen, distinguished service medals were presented by Assistant Secretary of War Benedict Crowell to Ralph M. Dravo, Chief of the Pittsburgh Ordnance District; E. A. Russell, Chief of the Chicago Ordnance District; B. A. Franklin, Chief of the Bridgeport Ordnance District; George J. Roberts, Chief of the New York Ordnance District; Fred J. Robinson, Chief of the Detroit Ordnance District; John C. Jones, Chief of the Philadelphia Ordnance District; and C. L. Harrison, Chief of the Cincinnati Ordnance District.

Necessity of A. O. A. Realized

The outstanding facts developed at this meeting were the realization on the part of the officials of the Ordnance Department of the need of intimate contact with American industry, not alone during war times but as the best means of preparation against war, and the readiness of American industry to co-operate with the Ordnance Department to this end, as expressed by the sentiment of the several hundred industrial leaders who were present.

Gen. Samuel McRoberts, vice-president of the National City Bank and a member of the founding committee, who acted as chairman of the meeting, spoke as follows:

I do not suppose there is any body of men in the United States who could take such an interest in the examination and discussion of ordnance material as those who are present. We have seen many interesting things today. We have also had the pleasure of renewing some of our personal associations of the war. We have reached the point where the war has produced more pleasurable conditions, but the great significant thing in this meeting is that we are here. It is entirely in line with the reputation that these men have established during the war, that they should leave their homes and make the long journey which many of them have made to join together in an effort to create an association for the preservation of the experience that American industry gained in the war and to preserve it for the use of the nation if, as is probable, she will need it in the future.

Our experiences in the war are so very recent and so vivid that there is no difficulty at this time to recall them. You will remember when the war broke out in Europe the art of designing, and the processes of manufacture, of war materials was practically unknown to the industrial plants of this country. It was really entirely unknown except to a very few plants that had been engaged in the manufacture of such material. That information was confined almost exclusively to the small corps of officers of the Ordnance Department and a small number of manufacturers who had been previously engaged in the industry.

Our Position Prior to the War

Even when we entered the war the information in respect to war material was exceedingly meager, and any idea of its design, or the difficulties that one would encounter in its manufacture, was still more meager. Furthermore, the Ordnance Department was entirely out of touch with the industry of the country. In the beginning of our war activities, they had to borrow in the Ordnance Department the mailing list of certain engineering journals to find out who were possible manufacturers in this country of the matériel that would be required. Now, that was not the fault of the Ordnance Department, as we all know, but it was a condition that existed at that time. Furthermore, the industry of the country was entirely out of touch with the Ordnance Department or the needs of the government or any plan that might have to be formulated for preparing for the war. It took the manufacturers many months to find out what was wanted. We will all testify that the large corporations of the country were eager to contribute their aid, but it really involved months of delay to find out even in a rough way what the necessities of the government were in the proposed armament of our forces.

And then, after we began to make our plans actively, owing to insufficient appropriation, insufficient organization, not lack of foresight, particularly, on the part of the officers, but lack of ability to prepare to meet conditions, we were not ready to manufacture what we knew we wanted.

We went through a heart-rending experience of trying to manufacture while we were developing designs. Everybody knows the result of that. The manufacturers of this country made a splendid record in the war. They in one way or another met the situation; and while I do not believe it is generally known what their sacrifices and efforts really amounted to, we can appreciate what these were, and at the same time

ARMY ORDNANCE NEWS

we recall the distressing conditions that attended the development of our Ordnance program.

We remember that although we submitted our plans to the munition manufacturers of this country—and we believed we had as expert manufacturers in this country as there were anywhere, and still believe so—it took us through months of heart-rending delay to develop a forging for the recuperator of our heavy artillery when we were in great need for it. Eventually, they got at it, and we moved on with the program.

We know that in such a small matter as the manufacture of boosters and adapters that our whole shell program was delayed for months owing purely and simply to the fact that there was not experience in the manufacture of even such a small thing.

We believe, gentlemen, that those conditions which existed at that time were totally unnecessary and believe that they should never exist again. You will agree that it was a national folly that they did exist, and it would certainly be national folly to let them exist in the future in the light of these experiences we have had.

This organization is formed for the purpose of avoiding that evil for the future. Whatever Congress thinks about it, whatever our political leaders think about it, or whatever the general public thinks about it at this time, we know that the proper Ordnance Department for this nation in time of war is the industrial plants and their resources, the industrial workers and the officers of the manufacturing companies coupled with the engineering and business brains of the country, under the guidance and leadership of the trained ordnance officers of the army. Anything less than that is insufficient and we believe that the proper Ordnance Department for this country in time of peace is the organization of the experts in the Army, organized as an independent corps, who can keep the industry of the country in touch with the latest developments, which can make the designs and test them out in the light of practical shop experience, and which is ready to put this great industrial army into active operation wherever and whenever it is needed. It is this combination that we want to bear in mind, and it is to secure that combination that this organization is formed.

The great advantage of this organization, as I see it today, is that it is not simply a reserve organization that we are forming and are going to put away to moulder on a shelf until some time when it is needed. It is needed right now. In fact, we are slow in the development of it.

The Army Reorganization Bill S-2715

There could be no better illustration of the necessity of this organization than the bill now pending in Congress for the reorganization of the Army. As I understand this bill, it very carefully ignores every lesson we learned in the war about ordnance preparation. It reduces the Ordnance Department practically to fifty men. It makes it impossible for the Ordnance Department to attract men with a bent and with a taste for engineering study and design, and the work that will be incident to keeping the Ordnance Department abreast of the times and ready for operation. Under this bill they can only get into the Ordnance Department after two years of service as a doctor or an engineer, or in the line, and if they are there any length of time, they must undergo two years' service in some other department, before being able to relieve themselves of the Army. In other words, a man who wanted to study engineering, and had an interest in Ordnance design, would not enlist in the Ordnance Department directly, but before entering the Ordnance Department, must have all his technical learning jolted out of him riding a caisson on some training field, or sweated out of him drilling troops at some tropical station in our foreign possessions.

It is this sort of thing that we can correct now, if we put our muscle into the situation without delay—there is no reason why it cannot be corrected.

Today, without any follow-up, but simply from the letter of invitation which was issued to those who might be interested in the formation of such an organization, we have an enrolled membership of eleven hundred and sixty. There is no reason why, in a few weeks' time, that enrollment should not reach at least ten thousand; and these ten thousand men understand this question, and understand it better than any others—in fact, they are the only people in this country who do understand it, and understand it in the light of these very recent experiences.

It is proposed to make this organization a big brother to the Department. We do not want to have occur in the future what has occurred in the past. Gen. Crozier went before Congress year after year and session after session and pointed out the situation which would occur in this country in case of war, but he was looked on as a special pleader and it had no effect. General Williams has appeared before the Congressional Committee and made a forceful and clear analysis of that bill, and just what its provisions mean, and it should be the duty of every man here to get General Williams' testimony and read it carefully. His testimony should be convincing and have the desired effect upon Congress, but he also may be regarded as a special pleader, a man talking about his own job. If this association is properly organized we can be of real assistance in that situation.

The Great Lesson of the War Was an Industrial Lesson

We know that the great lesson of this war was that the strength of the opposing sides, after all, rested in their ammunition factories, and that the scope of the military operations depended on these munition plants and the efficiency of their operation, and that the success of the war, on either side, rested primarily upon the resourcefulness and the ability of the munition makers. We do not want a great standing army in this country, and I think public opinion is clear on that question. We probably do not want universal training. That is not so clear. It is certain that the country will not maintain great arsenals for the manufacture of war materials in peace times, and if the proper steps are taken that is not necessary; but we can have an expert nucleus of an army, we can have a very large experience among civilians, ready as material for officers in case of need, and we can have an organization that will keep the Ordnance Department in touch with the manufacturers, and can keep the designers in touch with the manufacturers. We can have designs that will not only be good for Ordnance, but can be manufactured, and manufactured without delay—the patterns can be prepared and pilot material manufactured. This will make possible prompt and economic production whenever it is required. These simple preparations would have saved millions to this country and almost surely would have materially shortened the war.

The A. O. A. as an Effective Aid to Peace

It is the purpose of this organization to see that this condition is brought about. We are believers in all the efforts to create universal peace. No one discourages any good results that may come about through the organization of the League of Nations, but, on the other hand, we are not overlooking the fact that the most dependable preservation of peace comes from being ready to make a fight.

We do not want Uncle Sam to be armed to the teeth, but we do want to know that he can always put his hand on a gun, and that he has the facility for bringing it into instant service whenever it is needed.

I think this constitutes, as far as my mind conceives it, the purpose of this organization. The organization as it stands today is raw material, and must be systematized and organized and made effective, and it should be made effective with as little delay as possible, and before leaving here we should take some definite steps toward incorporating the organization, and appointing the necessary committees to follow up the work of organization.

Maj.-Gen. C. C. Williams, Chief of Ordnance, set forth the views of the Ordnance Department in the matter of necessary industrial preparedness as follows:

ARMY ORDNANCE NEWS

It is indeed a pleasure to be with you here today. My feeling of pleasure springs not alone from the always enjoyable reunion with old friends and the making of new ones, but rather from the agreeable consciousness that the Ordnance Problem is henceforth to receive the consideration that its importance demands.

The fact of your gathering here today in spite of the compelling calls of your private interests indicates a patriotic purpose on your part to exercise a continuing and effective interest in the Munitions Program, which the experience of the recent war demonstrated to be the controlling factor in the entire military program. As Hon. Benedict Crowell, the Assistant Secretary of War, states in his report as Director of Munitions: "The war taught us that America can organize, train, and transport troops of a superior sort at a rate which leaves far behind any program for the manufacture of munitions. It upset the previous opinion that adequate military preparedness is largely a question of trained man power."

War is no longer a duel of professional armies, armed and equipped from government arsenals, but a struggle between nations, with great numbers of the civil population drafted into the combat forces and armed on a scale requiring the complete mobilization of the nation's industry.

The military power of a nation depends, therefore, not alone upon its man power, but also and to an even greater extent, upon its industrial power. The military program, whatever its scale, must be considered not alone in terms of men, but also and fundamentally, in terms of munitions.

No Conception of Industrial Preparedness before 1917

In the years immediately preceding our entrance into the world war, "preparedness" meant a small increase in the Regular Army, stimulation of interest in the National Guard, summer training camps for business men and college boys, etc., but there was no agitation whatsoever for *preparedness from an industrial standpoint*. Apparently it was assumed that the only requisite of successful military preparation was the training of our youth in the use of arms in combat. Even today "preparedness" means computing the number of males of military age, discussing probable rejections for physical unfitness, and determining whether three months, six months or nine months are required to train our millions in the use of arms; when, as a matter of fact, discussion of this kind is purely academic, unless adequate preparation has been made to insure providing for these millions sufficient arms and equipment to make them effective in battle.

That being so, we should, as the very bedrock of our military program, take an accurate survey of our ordnance reserves and our munitions-producing field, establish a program of production that can be attained beyond any doubt and on that framework base our man-power program and all other phases of our preparedness.

You who have gathered here today recognize these statements as absolute facts, whether you have been in Government employ or in private employ during the war. You must also have begun to realize that few others than yourselves recognize the truth of these statements and the overpowering effect they have in the scheme for national preparedness.

I claim no pre-vision as to the future, no ability to predict whether or not there will be another war, nor if there is to be one, when it will occur or with what nation or nations. As long as we maintain a single battleship or a single regiment of troops it seems to me that we admit the possibility, if not the probability, of war. War means mobilizing the army against the armed forces of the enemy and you cannot have an army without ordnance.

Army Helpless without Adequate Industrial Backing

An army possessing the best possible morale, well-disciplined, well-organized, well-trained, with proper provision made for clothing it, for feeding it, for housing it, for paying it, for transporting it, is absolutely helpless as an effective military force, unless adequate provision is made for arming it. The nation, particularly the industry of the nation, knows perfectly well how to feed men, to clothe them, to house them, to transport them by rail, motor or horse, because the knowledge required to fulfill these functions is general, and furthermore is being constantly exercised in the daily life of the nation in peace time, but the nation does not naturally and as the result of its daily life know how to arm its manhood. Therein lies the crux of the whole proposition.

In the final analysis, the army is maintained in time of peace not merely to assist in maintaining law and order in the United States and its possessions, but primarily *to keep alive military knowledge*, for the use of such larger temporary forces as must be raised, trained, equipped and employed in the event of threatened or actual hostilities. The permanent force is, in effect, a small military laboratory striving to *preserve and extend military knowledge* in all its ramifications with a view to *developing methods* for training and equipping the man power of the nation along lines capable of ready expansion to a quantity-production basis in the event of war.

There are two phases of purely military knowledge which have no natural sphere of usefulness in the peace-time life of the nation, and therefore require artificial stimulation to keep them alive and abreast of the times: Knowledge of the use of arms; knowledge of the design and manufacture of arms.

For the training of the youth of the country to become commissioned officers, the Government has provided the splendid Military Academy at West Point.

For special training in the various branches of the line, we have the Army School of the Line, the Mounted Service School, the Coast Artillery School, the Field Artillery School of Fire, the School of Musketry, etc. For the higher education of selected officers in the art of war, we have the General Staff College at Washington, D. C.

In addition to these, provision is made for the support and training of the National Guard, for the Reserve Officers' Training Corps, and the Students' Corps.

All of these form a tremendous educational plant for the inculcation of discipline, the development of morale, the study of the principles of organization, the principles of strategy, and the ever-changing practices of tactics, all matters pertaining to the *use of arms* and having little or no *bearing upon the design and manufacture of arms*. In the past, we have allowed ourselves to be lulled into a false sense of security by adopting systems of military training which totally neglect the training of that technical personnel necessary to supervise the vast industrial army required for the production of munitions of war.

At the beginning of this war, a mere handful of Regular Army officers—97 in number—alone of all the millions in our land had taken sufficient interest in this important subject to study it enough to sense even vaguely its tremendous scope and importance. A considerable part of their energies was used in trying to convince the people of the United States, the Congress, even the officers of the Regular Army not immediately engaged upon ordnance work, that the Ordnance Problem was of paramount importance.

Regular Army Does Not Initiate War

I want you to bear in mind that of all the various elements of our population, the Regular Army plays the least effective part in starting wars. The officers and men of the Army and Navy alone of all adult males otherwise eligible to vote, cannot vote either directly or indirectly through their representatives for the declaration of war, nor can they influence national policies which tend to aggravate or to obviate recourse to arms in order to sustain the nation's contentions. What the Regular Army can do, and has done, is to hold as a sacred trust that military knowledge to which the nation has had recourse in the past for its own preservation, to maintain immediately available knowledge of how to stop war, to stop it by winning it.

This gathering together today of responsible men of affairs in the nation's industry is significant to me as indicating that in the future there is to be a joint trusteeship of the Ordnance Problem. The part of those who remain in the government service is to keep alive knowledge of the scientific engineering and industrial processes incident to the manufacture of weap-

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ons of war, and the part of those not now in government service is primarily to establish the fact beyond any peradventure of a doubt that the Ordnance Problem is indeed a problem—a problem that in the recent war engrossed the attention of every phase of scientific research, every application of modern engineering, and every known industrial process, that aside from the scope of its ramifications, its mere size will of itself demand the best brains and energy that America can give to it.

I take it to be your mission as an Association that, having been through the mill yourselves, you can say, of your own knowledge, that military preparedness must be based upon prior industrial preparedness; that consideration of ways and means to solve the Ordnance Problem must have absolute priority over all other phases of preparedness; that American industry, upon whom falls the burden of supplying the materials of war, demands its opportunity to prepare itself for its war task, not only on equal terms with, but even in advance of, measures concerned with the purely man-power features of preparedness.

Only a year ago today our forces were engaged in the great Meuse-Argonne conflict, that desperate struggle to cut the German lines of communication at Sedan and force withdrawal. While this tremendous struggle was going on overseas, four million people employed in eight thousand plants in the United States were engaged in turning out the two hundred thousand odd separate and distinct articles required for assemblage into complete units of ordnance.

Germany Realized Our Tremendous Industrial Power

You well know the strenuous measures and heroic remedies we used to supply our soldiers with adequate equipment and matériel. The great war-time industrial machine was getting up speed. Quantity production of every essential item was in sight. The Army Ordnance Program was *going through*, and Germany realized all this and sued for peace.

And now within the year that great industrial machine has been checked in its onward course; it has been largely, almost completely, diverted to the production of materials of peace, and you who had turned over your plants to the nation, and you who assisted in handling the Government's side of the countless claims and adjustments incident to the cessation of munitions production, have performed a task no less valuable to the nation, no less wonderful in its way, than the manner in which you built up the great industrial war machine.

When I reflect upon the industrial miracle you wrought during the war, and upon the fairness and co-operation you have shown in readjusting the nation's industry to a peace basis, I realize that you have not only the ability but the spirit of public service necessary to effect that condition of industrial preparedness for war that, in the future, will be one of our greatest guarantees of peace.

General J. H. Rice Tells His Experiences

Gen. John H. Rice, recently returned from France, where he served for more than a year as Chief Ordnance Officer of the A. E. F., in addition to describing ordnance activities abroad, spoke as follows regarding the problems before the new organization:

Gentlemen of the Army Ordnance Association: It is impossible for me to tell you how great is my pleasure at being given this opportunity to address the Army Ordnance Association and to take my place as a member at this first meeting following the termination of the World War, in which we were all so vitally concerned and in which we all played an active part. It is particularly gratifying to me because of my appreciation of the fact that you gentlemen and your associates really fought the war so far as pertains to American industrial ordnance, and that it was a good fight made with true American enterprise and enthusiasm.

It was my good fortune to have been for some time before the war the chief of one of the divisions in the office of the Chief of Ordnance and to have been concerned with the ordnance events leading up to the war as well as those during the war. It may be of passing interest to give you an idea of one corner of the state of unpreparedness that existed when the war began, to the end that you gentlemen in common with other patriotic citizens may make it your business to see that we do not revert to similar conditions.

My division of the ordnance office was charged with the design, procurement, inspection, storage and issue for the United States Army of all field- and seacoast-gun carriages with their sights, fire-control instruments and other equipment; all machine guns and automatic machine rifles, and all special motor equipment which included tractors, ammunition trucks, tanks, armored automobiles, machine-gun trucks, reconnaissance cars, staff observation cars, etc. For this work we had a total of six officers, nine clerks and less than one hundred draftsmen. As illustrating the sufficiency of our equipment for a major war we had on hand 225 batteries of field artillery of calibers up to and including 6-in. with none of larger caliber. We had an assorted lot of machine guns, Vickers-Maxim, Colt, Vickers and Benet-Mercier amounting to 1489 in all. We had no tanks or designs therefor but we possessed two or three experimental armored automobiles, a dozen or so commercial caterpillar tractors, no ammunition trucks and no other motor equipment. By way of comparison it may be stated that when the Armistice was signed we had on hand or under contract 5140 batteries for field artillery, including 75-mm. guns, 4.7-in. guns, 155-mm. howitzers; and of heavier calibers of field artillery 389 batteries, including 8-in., 9.2-in. and 240-mm. howitzers; amounting in all to 5529 batteries. This does not count railway artillery which included 645 guns. We also had in our possession or under contract 175,161 heavy machine guns; 190,700 aircraft machine guns; 4750 ground type Lewis machine guns; 305,174 Browning automatic rifles; making in all 675,785 machine guns and automatic machine rifles. We had also on hand and under contract 24,791 caterpillar tractors; 20,440 light tanks; 3000 heavy tanks; and 12,508 other motor vehicles. The total amount appropriated and authorized for artillery, including special motor equipment, was $3,188,241,085 for machine guns, $1,102,629,000 for tanks and $428,540,217 for armored motor cars, or a total of $4,719,000,000.

You are, of course, fully aware of the fact that the neck of the bottle so far as concerns preparedness for war is the ability of a nation to produce munitions, and that any nation must go to war with the equipment which it has on hand at the time war is declared, unless it is fortunate enough to have an outside protector such as the United States had in its Allies during the World War. Certainly, nobody knows better than you that nowadays war is conducted by the entire people and not by any military class. In the future as in the recent past the burden of industrial production will fall upon you gentlemen who so ably operated plants producing ordnance matériel, and you gentlemen who gave up your usual pursuits to accept commissions in the Ordnance Department. It, therefore, is a great comfort to us to feel that you and your associates will be actively interested in seeing that no such pitiful state of unpreparedness as I have already illustrated is allowed to recur.

Almost Insurmountable Difficulties

The difficulties under which you labored—you who manufactured ordnance, and you who joined the little scrap of a Regular Ordnance Department—if fully foreseen before our entry into the war, would have seemed well nigh insurmountable. Lack of organization, lack of machinery, lack of control of raw materials, lack of control of transportation and coal, lack of buildings, lack of competent mechanics, and the lack of experience, when coupled with the enormous program it was necessary to undertake, constituted a problem of no mean magnitude. Nevertheless, the success attained was a particularly remarkable achievement. There were actually produced 3,866,346 small-arms rifles, 192,160 machine guns and automatic machine rifles, 3,861,882,327 rounds of small-arms ammunition, 28,689,829 rounds of artillery ammunition, 7508 caterpillar tractors, 2,728,426 sets of personal equipment, and I might go on naming indefinitely. When the Armistice was signed we had

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reached that condition wherein the limitation on deliveries at the front would shortly have been wholly one of transportation facilities. Material had begun to flow into France in huge quantities and the stream was daily increasing enormously. There had been erected in France hitherto unheard-of storage space for general supplies and for ammunition as well as enormous manufacturing and repair plants. In short, an industrial giant such as had never before been known was coming into full activity. There is no question that one of the determining features of Germany's defeat, if not the most important feature of all, was her knowledge of the tremendous industrial preparations and achievements of the United States and the whole-hearted energy with which you gentlemen and your associates were prosecuting the industrial program. That program absolutely insured her ultimate defeat and she was wise enough to recognize the fact.

America's Broad Conception of War Problems

No feature of America's participation in the war was more commented upon by her Allies than the fact that we went about the business as if the war was going to last indefinitely and on a scale that contemplated having four million men in the field by July, 1919; whereas they had prepared piecemeal by successive steps and on a relatively small scale. Particular comment upon this fact was made to me by authoritative representatives of the British Government while I was in France.

As the Chief of Manufacture in the Ordnance Office I am confidently expecting to maintain, and, if possible, to extend the close and cordial relations which have existed most noticeably during the war between the Ordnance Department and the manufacturers of the country. The Manufacturing Divisions of the Ordnance Office are responsible for making or otherwise procuring detailed designs for all ordnance equipment, producing and developing the experimental material, procuring, inspecting and delivering to the Field Service all of the military matériel, ammunition, etc., furnished by the Ordnance Department.

Many New Designs Coming

In this work there will be many new dseigns in which we earnestly hope to retain the interest of the engineers and manufacturers of the country. We expect to procure complete original designs and we are also planning to ask for manufacturers' help on the designs we make ourselves.

The designing and manufacturing work of the Ordnance Department prior to the recent war was not often even approximately wholesale but was in fact a very small affair. The methods of quantity production had been possible only in the most limited degree in the arsenals of the country because as a rule the orders were not large enough for the purpose. The demands for high-grade matériel, often for light weight, and for many other refinements, were too often the determining factors in design and the lack of sufficient numbers for quantity production deprived us of the automatic correction and inducement to simplification of design which came with the large undertakings of the war. I may add that this difficulty was by no means limited to the United States but was also the experience of her Allies. We are relying upon your assistance to save the Government and yourselves from similar difficulty in the next war. In other words, it is my expectation to be able to secure your constant advice and assistance in the designs that are prepared to insure that they are adapted to quantity production and to the equipment that may be most readily obtained in the country.

As illustrating the kind of assistance that we are expecting to secure one experience of the recent war is illuminating. The French and ourselves had what amounted to a common program in many respects, one of which was for railway artillery. It was planned that as far as possible the equipment of each type should be furnished for both governments of one design and from one agency. For the larger calibers, such as the 14-in., this meant manufacturing in the United States. The type of gun and mount wanted was known in great detail in France and the French firm of Schneider & Co. collaborated with our engineers in the production of a design for a 14-in. gun. Fearing, however, that such a design might not be well adapted to the manufacturing capacities and methods of the United States, it was requested that engineers from this side visit France to assist in the completion of the designs and to adapt them to American practice. As a result engineers from the Morgan Engineering Co., the Baldwin Locomotive Works, the American Bridge Co. and the Ordnance Department here visited France and assisted in the completion of a 14-in. gun and carriage.

As finally laid down by this method the mount was capable of production in this country in three months whereas if it had been completed in accordance with the French practice it would have taken at least nine months and in fact some parts would hardly have been possible of production at all under conditions then existing. The work of these civilian engineers was of the greatest value to the Government and though the emergency then existing has disappeared we are confident that we shall be able to find among the manufacturers of the country the same whole-hearted and disinterested desire to help in the future that existed during the war. Assuming this to be the case, and that we are able to secure sufficient appropriations to carry on the necessary experimental and development work, I am confident that the United States, from having heretofore been too often a trailer in military designing and development, will take its place at the head of the procession. I need hardly say that if this part of the work is to measure up to the position already occupied by the United States for inventive ingenuity, for genius in organization and for efficient and economic production, it will have to head the procession.

Before leaving the subject of the manufacturing work of the Department I wish to say that we consider this business to be your business and that we are hoping and expecting to have freely your advice and assistance.

Colonel Schull Sketches Growth of Aberdeen Proving Ground

Col. H. W. Schull, Commanding Officer of the Aberdeen Proving Ground, sketched the growth of the Ground from the time it was acquired by the United States in the latter part of 1917, to the present advanced development.

The tentative constitution of the Army Ordnance Association was unanimously adopted by the members present and the founding committee was designated as the executive committee to prepare a ballot for officers and proceed with the incorporation of the Association.

Sammy's Shop—Expert Advice on the Cornshelling Business

By W. Osborne

Yes, business was bad. The cornshelling business was not what it should be. Mr. Brown seemed to think that the state of the business was because of some lack in Sammy, and Sammy did not know what to think. Mr. Brown had one great advantage over Sammy. He could put the matter up to Sammy and then go away and leave it. This he did and there Sammy was with it, and nobody was around that he could in turn put it off on.

Sammy gloomed over the matter and tried to find out the why of the discouraging situation. Business had been bad for three full years. Orders! No, not that. Every mail seemed to be raining orders, or hard words because they were not being filled, and people were not particular about prices either. What they wanted was cornshelling machines, and more cornshelling machines.

It was something awful to be trying to build cornshelling machines when workmen were in the army, or in the war-work factories, or just floating around the country; and the machines had to be built with

those who consented to have a hand at them because they could not pass off for mechanics at some kind of government work where they could be lost in the crowd. Material? Why, anything that was not of use for anything else, and that you had to have so bad that you would pay more for it than could be extracted elsewhere, could be bought—you understand—it could be bought. Then, did you get this material? Certainly you got it, some time—and sometimes.

You got it if someone else did not want it bad enough to pay a higher price before it was shipped, and something did not interfere between the shipping point and you; that is, if an embargo was not placed on that kind of material, or on any of the territory interested.

You got it in driblets, and you got it in deluges, and the deluges were, of course, the substitutes that you would not use except under the spur of grim necessity.

It is said that no night is absolutely dark, and so even here was an occasional ray of light.

One piece needed strength and had been originally made of steel. A steel casting was used. A malleable casting had then been tried and found strong enough and they were being used when the war started. Some of you may know how it was getting malleable castings in small lots if they required skilled molding. A few forgings were made and Sammy nearly shed tears when he saw them and tried to have one of the new "hands" machine them. In despair, he had the foundry make some from the strong cast iron and tested them for strength and succeeded in breaking most everything around them without one of them breaking, and then he felt better about the future as far as that part was concerned. Oh, yes, certainly he felt bad, too, thinking about all the money that had been lost in making the past ones out of steel and malleable castings.

A number of other things could be mentioned that did not tend to put speed into the production, and above it all the chorus calling for cornshelling machines.

Just think of it, will you, the money to be made if——

Now all this is changed—men coming in a steady stream asking, and even demanding, work; salesmen, with the genial smile and the glad hand, offering material. But where, oh, where is that chorus? Where is that demand that was such a nightmare when it could not be filled?

If Sammy's shop is to give work to a lot more men it must make a lot more cornshelling machines. To make a lot more they must sell a lot more, and how are they going to sell them?

Advertised? Why, of course. Sammy has a book right by him that explains that advertising is the sure and true basis of all business that gets to be more than local. It shows that you should advertise in good times just to show the public that you appreciate their patronage and that you should advertise in poor times because it is business suicide to do otherwise. Sammy has to acknowledge the force of the reasoning, but Mr. Brown looks after the advertising.

That book on salesmanship and the value and indispensability of the traveling salesman is also very convincing, but again Mr. Brown has that matter in his hands.

Perhaps an increase in the advertising and more traveling salesmen would be a help but that is outside of building the cornshelling machines.

One of the dealers who hands the cornshelling machines out to the public has a sure remedy. He says that he got it from the using public, and it is to lower the selling price. He puts up an argument, too. Pig iron has come down; steel has come down. Most of the cornshelling machine is pig iron and steel.

Sammy considers the matter. He looks at the figures. He finds that most of the cornshelling machine is labor and that is still going up. He finds that the depreciation of the tools and fixtures has been much greater than had been allowed for. He finds that the quality of the workmanship will have to be brought back to former standards. He finds that taxes, insurance and freights have been going up since the last advance in the price of cornshelling machines. He finds that the hours in a day have been decreasing and with it the work done in an hour has been decreasing. He finds that because of the long time that it had been taking to get material that the stock on hand was much above normal and that the amount still ordered and being delivered was above normal, and that all of this was at the high level of prices. Cornshelling machines were not used as implements of destruction in the war, and so he was not making war essentials and he found that it had not been a profitable time for his business.

He finds a multitude of movements on foot which have to be financed by the public without any financial return, and he finds that the promoters of each one of these movements demand of him donations that do not take into consideration that there are others also demanding of him.

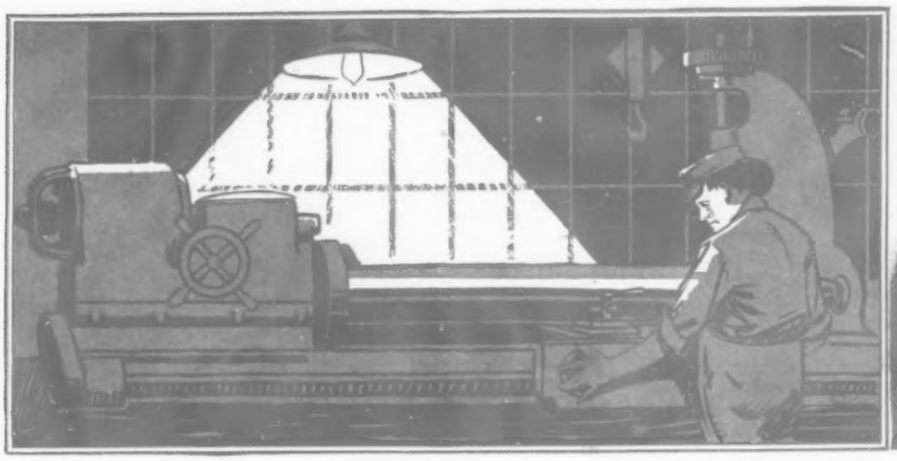
He finds that for some reason that is not at all clear to him that there is a decided hostility in the press, the pulpit and among public speakers to him as a manufacturer, and an assumption that manufacturers are public enemies who have been robbing the public and slaughtering their employees for gain, and the fact that one has continued in business is proof positive of his guilt. It may be that those in his immediate locality give him faint praise, but his class is held up for condemnation.

He turns to his own particular technical press and finds it full of articles which tell him that he does not know the A-B-C's of his own business. Each one of them tells him of the infallible remedy for all of his ills. Each has a different remedy or a different way of applying it, and most awful and distressing things are foretold if he does not call in an expert to administer it. He is told of the calamitous fate of those who interfere in any way while the remedy is being applied; and many of them offer proof by telling of the things which they have done to railroads, and ships, and making war machinery, and point with pride to the Standard Oil Co., the maker of the "Tin Lizzie," and the United Steel Corporation as proof.

Some way or another the impression is left that he is the "goat" and that everything that he does is so far from being as it should be that he should be glad that he is allowed to remain on the business earth.

Sammy feels that he would gladly go some distance to see one of the perfect establishments if one could be found owned and managed by one of these literary experts, and ran strictly in all things according to the rules and specifications as hereunto laid down and promulgated. He would like to see it after it was a number of years old.

Just now Sammy finds that the employees expect their pay on pay day. He finds that the banks still demand security before lending money. Well, he finds out a lot of other "practical" things that seem to have a whole lot of determining influence in making cornshelling machines, and out of all of it he sometimes wonders if it would not have been better if he had got into some other kind of business where the results of what he did could not so easily be checked up against him.



LIGHT, ELECTRICITY and The Shop

By C. E. Clewell

The Care of Shop Motors

This article takes up the question of the care of electric motors under shop conditions. Notes are included on the general instructions to be followed in setting up motors for the first time, together with some cautions on the manipulation of electric machinery.

IN CERTAIN electric motors for shop purposes special attention is given to some features in their design which can be used as an aid to ready inspection and repair. As an illustration, note the hand hole of the motor shown in Fig. 1.[1] Such construction makes it possible to inspect the brush rigging and the commutator conveniently. Relatively large covers are located over the bearings at *A* and *B* through which it is possible to inspect the bearings and oil rings whenever desirable.

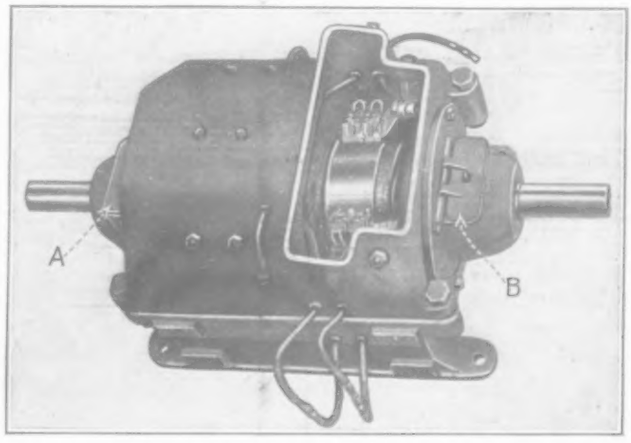


FIG. 1. CRANE AND HOIST MOTOR WITH HAND-HOLE COVER REMOVED

In Fig. 2 a motor is shown with the top portion of the frame removed, making it possible to inspect the entire interior of the motor with ease. One of the fundamental requirements for the successful operation of shop motors is that the insulation shall be in good condition. Sometimes, however, the insulation becomes damaged from mechanical causes or it may have been exposed to moisture during shipment, making it desirable to test its value before the motor is put into operation. In general the higher the resistance of the insulation the better is its condition. If the insulation resistance is abnormally low, due to moisture, the only way to increase it is to dry out the machine.

An instrument termed the "meger" may be used for testing insulation but if it is not available then a voltmeter with electrical connections as indicated in Fig. 3 may be used. A 500-volt instrument and a 500-volt supply circuit are desirable for such a test. By this means a reading may be taken of the line or supply voltage, and then by throwing the switch to the other position to take a reading of the voltmeter and the resistance to be measured in series with each other. In this case the resistance of the insulation under test may be found by applying the following equation:

$$R = \frac{r\,(V - v)}{v\,(1{,}000{,}000)}$$

where V is the line voltage, v is the reading of the voltmeter when the the insulation to be measured is in series with the instrument, r is the resistance of the voltmeter in ohms (the value of which is usually marked on a label on the inside of the cover of the instrument), and R is the resistance of the insulation under test in megohms, that is, where the megohm is equal to 1,000,000 ohms. The method of connecting the apparatus is clearly indicated.

If a grounded circuit is employed in making this test then the grounded side of the supply circuit is to be connected to the frame of the machine and the voltmeter is to be connected between the insulation under test and the other side of the supply circuit.

If a voltmeter is used having a resistance of 1,000,000 ohms, r then equals 1,000,000 in the foregoing equation and the equation as a whole reduces to the simple expression:

$$R = \frac{V}{v} - 1.$$

A safe rule in such work is that the insulation resistance should be approximately one megohm for each 10,000 volts applied to the machine under test, but that no

[1]Figs. 1 and 2 are shown by courtesy of the General Electric Co.; Figs. 3, 4 and 6 of the Westinghouse Electric and Manufacturing Co., and Fig. 5 of the Wagner Electric and Manufacturing Co. The author herewith acknowledges the coöperation of these companies in connection with data and information placed at his disposal for use in the preparation of this article. In particular numerous references are made in the present articles to information supplied by the first two plants mentioned. Some reference has also been made to the author's "Handbook of Machine Shop Electricity," McGraw-Hill Book Co., New York.

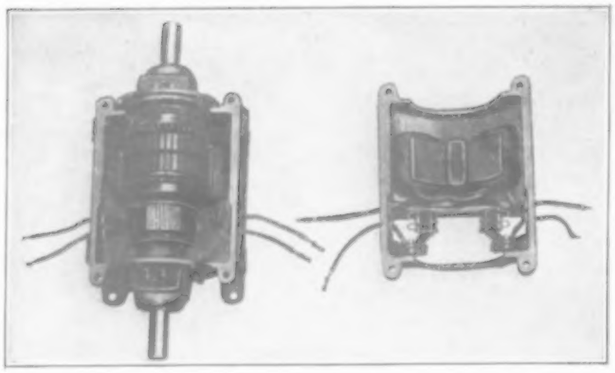


FIG. 2. MILL MOTOR WITH THE UPPER HALF OF THE FRAME REMOVED

machine should have insulation resistance less than one megohm.

One of the essential requirements for the successful operation of motors is that they be kept dry. If a motor has been exposed to moisture, therefore, it is important that the winding be thoroughly dried out before it is placed in operation again. With small motors drying may be accomplished by simply placing the motor in an oven. With the larger sizes, and in fact with all sizes, it is possible to dry out the motor by sending through the winding of the motor an electric current of sufficient quantity to bring up the temperature of the windings to say 85 deg. C. This temperature ought to be arrived at gradually and maintained as uniform as possible throughout the machine for a period ranging from a day to a week, depending on the size and the voltage of the motor.

Location and Mounting

Manufacturers of motors advocate their use under clean and dry conditions in a well-ventilated place where they will be in sight and readily accessible. It is not always possible to meet all of these conditions, but as far as practicable they should be met. In particular no machine should be placed where it will be subject to the dripping of water from steam pipes or from other causes, and they should also be kept as free as possible from grease and dirt unless some special construction of the motor frame, Fig. 4, makes such a course unnecessary.

Cleanliness is of course an important consideration, but it is not always possible to use the motor under ideal conditions from this standpoint. Fig. 5 shows a

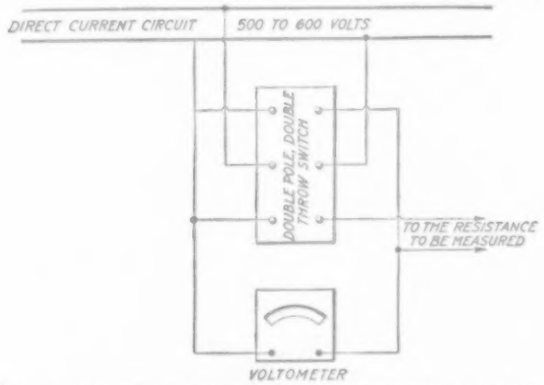


FIG. 3. SIMPLE ELECTRICAL-CONNECTION DIAGRAM SHOWING A METHOD FOR MEASURING THE INSULATION RESISTANCE OF A MOTOR

motor working under conditions that create dust and lint in the air. Sometimes the motor may be placed so as to minimize such a condition, as in Fig. 6 where one is shown mounted well above the body of the machine to which it is connected.

Acid fumes are very harmful to an exposed motor, and furthermore it may be stated that with ordinary motors the surrounding temperature should not be so high as to cause the motor to operate at a temperature above 90 deg. C., though with special kinds of insulation this may be considerably exceeded without injury.

Bearings

When a motor is started up for the first time it is important that the bearings be properly lubricated and, if furnished with ring-type bearings, that the oil rings rotate freely and properly carry the oil to the top of the journals. Standard motors are provided with liberal bearing surfaces and should not show signs of

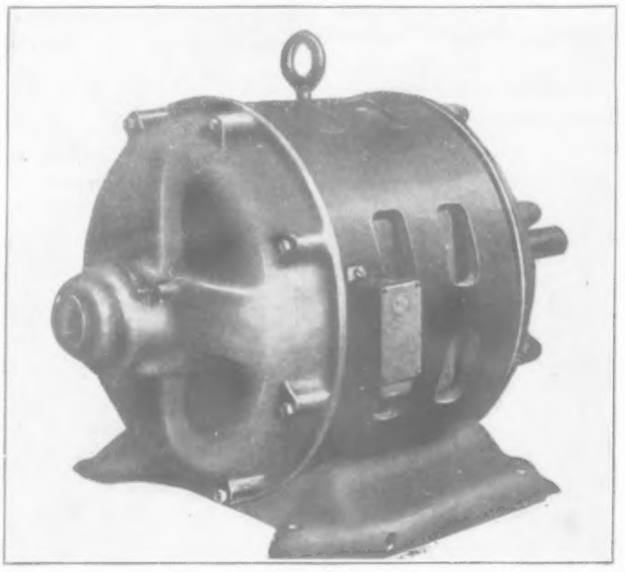


FIG. 4. INCLOSED MOTOR

undue heating, but such heating may at times be produced by special causes as follows:

The belt tension may be excessive; the lubrication may be inadequate, due to either the use of a poor lubricant, to an insufficient quantity of oil or to a failure of the oil rings to revolve, and in motors with oil and waste bearings to a poor grade of waste. Other causes of heating may be the poor alignment, or leveling of the motor shaft, which may cause an undue end thrust or a tendency to bind in the bearings; the bearing surfaces may be rough, due to careless handling or, sometimes, to the presence in the oil or waste of dirt and grit, and finally the shaft itself may be bent.

Where the motor bearings operate steadily at a temperature below 100 deg. C. (212 deg. F.) it may usually be considered as in a safe condition, but any signs of a rapid rise in temperature should be regarded as dangerous. Other indications of a wrong condition are the smell of burning oil and also the feeling of the bearings.

Where abnormal conditions are found to exist supply the bearings with a good quantity of fresh, clean lubricant and make sure that it reaches them and see that the

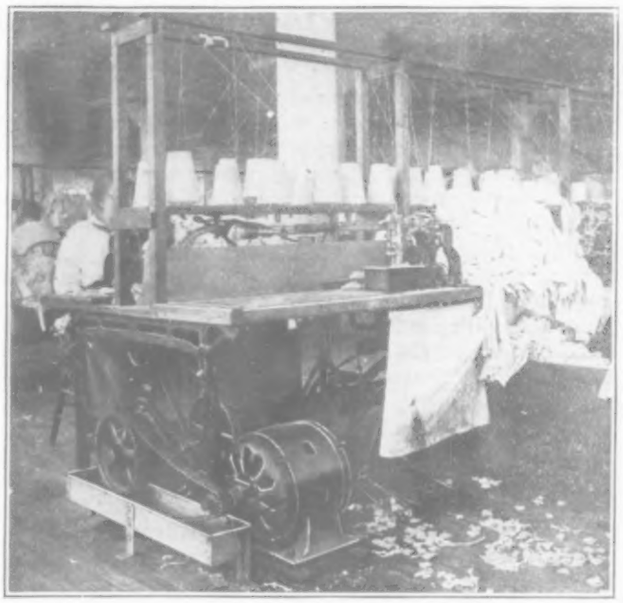


FIG. 5. TEXTILE MOTOR UNDER OPERATING CONDITIONS

belt tension is not in excess. In case this does not help, pour heavy oil directly on the journals, if possible, and remove as much of the load as practicable, keeping the motor running to prevent the bearings from setting or "freezing."

An item of importance in the everyday operation of motors is the belting used to transmit the power from the motor to the machinery being driven. It is recommended that with pulleys having faces up to 12 in. the belts should have a width at least 1 in. less than the face of the pulley, whereas with a pulley face over 12 in. in width the belt width should be at least 2 in. less.

The lower side of the belt should ordinarily be the driving side and the distance between pulleys should be great enough to produce a sag in the upper part of the belt. If not, then an idler pulley is recommended to increase the arc of belt contact.

Under the head of repairs that can often be handled by the local shop department are such matters as the relining of bearings, the substitution of new insulation for defective insulation in certain cases, and the like.

Where it may be necessary to dismantle a motor to get at certain parts for repair, a good deal of care is warranted in noting all attachments and in making notes, if necessary, as the work of dismantling progresses. In like manner when the parts are reassembled care should be exercised to see that each attachment has its proper place, and in all such work the various parts of the machine should be protected from injury not only during the process of dismantling but also in disposing of the parts while the repairs are being made and during the operation of reassembling again.

For the more difficult repairs, the repair departments of the manufacturing companies which sell the motors should be depended upon. Nearly all motor companies maintain such repair departments in the larger cities, and their practice is to employ men who have had experience in the building of motors for this repair work. Better work and economy in both time and expense may result from such a course.

A number of cautions may well be given in the form of a guide to special features in the operation of electric motors. Thus the load on a series motor of the direct-current type should never be completely removed when connected to the supply circuit nor should the load be reduced to such an extent as to make the motor attain a dangerously high speed. Belting is not recommended for the series motor on account of the risk of the belt coming off and thus permitting the motor to race.

The shunt-field winding of a direct-current motor should not be opened while the motor is connected to the line. Such a course will tend to make the motor race and may produce serious damage.

In opening the field circuit of a motor of the shunt type do not open the switch quickly unless some form of discharge is provided. If the switch is opened gradually the arc formed at the switch contacts will serve to reduce the field current gradually. Too rapid a reduction of the field current induces excessive voltage in the field winding and this may puncture the insulation of the winding. It is important to prevent the body from bridging the gap caused by opening such a field circuit on account of the high voltages produced and the shock that may result. A good rule in such cases is to use only one hand in operating the switch and to keep the other parts of the body entirely clear of the circuit.

In soldering do not use an acid that will attack the insulation or the copper. A good soldering flux is composed of an alcoholic solution of rosin.

In soldering the connections to a commutator take care that small particles of solder do not fall between the adjacent bars of the commutator. If this happens the solder may short-circuit a portion of the commutator.

System and regularity in the operation and inspection of parts, also in the lubrication of the motors, are recommended if the best results are expected. When motors are not running see that all the switches are open[2].

The following hints are taken from the handbook of the National Electric Light Association and may prove of interest to the shop operator who is confronted with the problem of the care of a motor. They are not

[2]These cautions are based on Instruction Book 5141 of the Westinghouse Electric and Manufacturing Co. on the installation, operation, care and repair of motors and generators in industrial service.

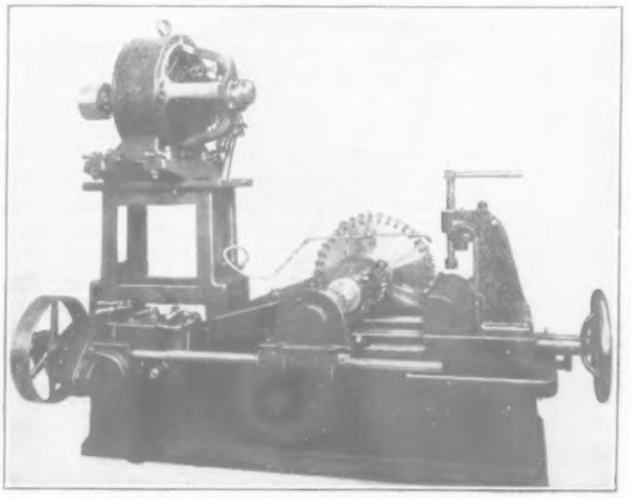


FIG. 6. MACHINE WITH ITS INDIVIDUAL MOTOR MOUNTED WELL ABOVE THE MACHINE FRAME

given as complete suggestions in such work, and where a more thorough and detailed list of items is desired the reader should refer to the instruction books of the motor manufacturers themselves or to some reference book.

Cleanliness.—Electric motors should be kept clean and free from superfluous dust and oil. The brushes should bear firmly and evenly on the commutator and occasionally the commutator itself should be cleansed with a soft cloth on which a few drops of oil or vaseline have been placed.

Commutator.—When the commutator gets rough it should be smoothed down with a very fine piece of sandpaper (do not use emery cloth) and when operating properly will assume a gloss of light chocolate color.

Oil Rings.—The oil rings should always revolve freely, and occasionally the oil should be drawn off from the oil well and the well cleaned out with paraffin oil and then refilled with fresh lubricating oil.

Brushes.—The brushes should be so adjusted as not to spark under normal load and should be kept in this position. The tension of the brushes on the commutator should be light but firm, sufficient for perfect contact without undue friction.

Starting.—In starting a motor first close the main switch, then move the starting lever of the rheostat, or compensator, forward slowly and steadily, letting the motor come up to speed gradually. In stopping the motor always open the main switch first. The contact points should be occasionally cleaned to preserve a perfect contact for the starting lever.

Heating.—It is well to occasionally feel the bearings and various connections to ascertain if they are heating to a temperature higher than normal. If such heating is found it usually indicates an overload or a loose joint on the motor, and in either case it should be remedied at once.

Apprentices Here and in Europe

BY A. ELLSWORTH

I wish to take exception to the statement, on page 655, by Fred Price that talks of the superiority of European mechanics is "rot, pure and simple." Much as it distresses me to acknowledge it, the fact cannot be blinked that most workmen trained abroad are far and away above the average domestic product.

Mr. Price will note that I say *trained*, not born, abroad. Boys of foreign birth or parentage trained in this country do not as a rule make themselves conspicuous in the trades, but I have noticed in long years of association with workmen that the men to select for the unusual or delicate jobs were those who had a burr of some kind on their tongue, indicating that they had passed their boyhood and youth in some country other than ours.

I have worked with and have had in my employ, Englishmen, Scotchmen, Swedes, Frenchmen and Germans, whose skill was greater and whose knowledge of their trade was more comprehensive than any but the exceptional American. One of the best toolmakers I ever knew was an Englishman, born and raised in Manchester. He received his training from Englishmen, under English conditions and customs, but in a shop that in machinery and methods was thoroughly American—Mergenthaler, Ltd., Manchester, England. He served a seven years' apprenticeship.

The best patternmaker I know is a Dane who, until he was 25 years old, never knew there was any country but Denmark. He served a seven years' apprenticeship.

An exceptionally resourceful all-round mechanic, who could do any conceivable thing connected with a machine shop that did not require what we are pleased to call "executive ability," and do it well, was a Swede who in his own country had served a seven years' apprenticeship.

Note the repetition of these words: "he served a seven years' apprenticeship." If I were to catalog the exceptional foreign-trained men with whom I have come in contact, that statement would become as monotonous as a history of the achievements of Coriantumr in the Mormon bible, who "slew" pretty much everybody in sight.

I do not say that the mystic number seven, as applied to the years of their apprenticeship, had any magic effect upon the degrees of skill and ability acquired by the apprentices, but I do wish to emphasize the fact that when the master-workman of Europe set out to do a good job he took plenty of time about it.

When a boy became "bound" according to the customs of the older countries, the master was also involved in the binding. While the boy, through the act of his natural guardian, legally gave to the master his services, his allegiance, and adopted the relationship of son to father, the master was likewise under legal obligation (by which he could be held strictly accountable) to give the boy every opportunity and assistance in learning his chosen trade.

He was further obligated, by custom and tradition, to turn out a good product. A poor or indifferent workman was a greater disgrace to the master than poor work, and would cause him to lose prestige and consequent business.

The terms of indenture were, of course, varied. Sometimes a cash consideration was included; sometimes not. Oftener, the boy became a member of the master's family and was fed, clothed, schooled, thrashed, and otherwise looked after as a son of the house.

Sometimes the master was brutal. I have been told of kicks and blows administered by apparently heartless masters to helpless apprentices; of masters who half starved their boys; of some who compelled their boys to work long hours without sufficient rest; but I have never heard the complaint that a European master-workman neglected or shirked an opportunity of instructing an apprentice.

Though many an erstwhile apprentice formed a fierce resolve to murder his master at the first opportunity, he generally didn't do it, and in later years would cheerfully admit that the "old man" was of a pretty good sort after all.

The point is that the European master-workman considered it his first duty, as far as the boy was concerned, to make a workman out of him. The "old man" of the early American machine shop thought so too, and the percentage of good workmen turned out by him was high; but in later years he has been too busy and competition too keen to permit him to worry about a boy's welfare. "There's the shop and there's the boy; if he can't learn the trade and pay a profit too, he isn't much of a boy." Suppose we ran our schools that way?

I want very much to believe Mr. Price's statement that the machine shop is the place to teach the machinist's trade, but I must make a few reservations. It must be a machine shop, not a machinery manufacturing establishment; and its first consideration, so far as the boys are concerned, must be the making of workmen. Just now the school shop seems to be the best answer.

Electro-Percussive Welding

By ETHAN VIALL
Managing Editor, *American Machinist*

This method of welding, while nearly 15 years old, is little known outside of some of the electrical concerns, where it is used principally for joining wires. Its possible uses for many processes in jewelry or similar manufacturing have not yet been extensively tried.

THE joining of small aluminum wires has always presented much difficulty on account of the oxide film which prevents the metal parts from flowing together, unless brought to a point of fluidity at which the oxide film can be broken up and washed away. If this be attempted with small sections, the whole mass is likely to be oxidized, and the resulting joint will be brittle or "crumbly."

In 1905, L. W. Chubb, of the Westinghouse Electric and Manufacturing Co., Pittsburgh, Penn., discovered that if two pieces of wire were connected to the terminals of a charged condenser, and then brought together with some force, that enough electrical energy would be concentrated at the point of contact to melt the wires, while the force of the blow would weld them together. Accordingly, a welding process was developed and used by the Westinghouse company, and machines made which are capable of welding all kinds of wire up to No. 13 gage. The process was called electro-percussive welding, and a machine for doing the work is shown in Fig. 1. This machine has vertical guides *A* between which travels a chuck *B* holding one wire *C*. The other wire is held below in chuck *D* in such a position that the end of the moving wire strikes it squarely.

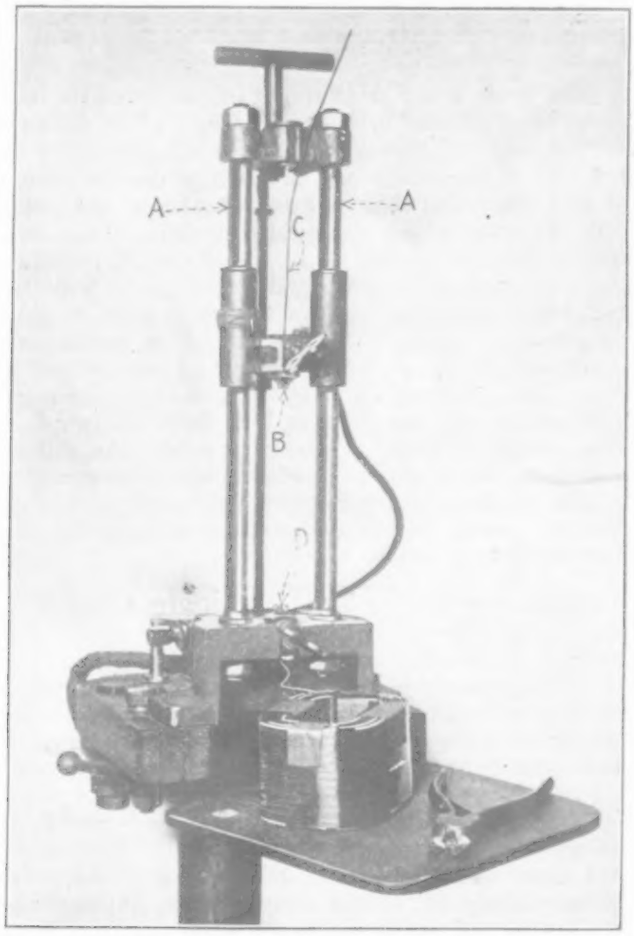


FIG. 1. ELECTRO-PERCUSSIVE WELDING MACHINE

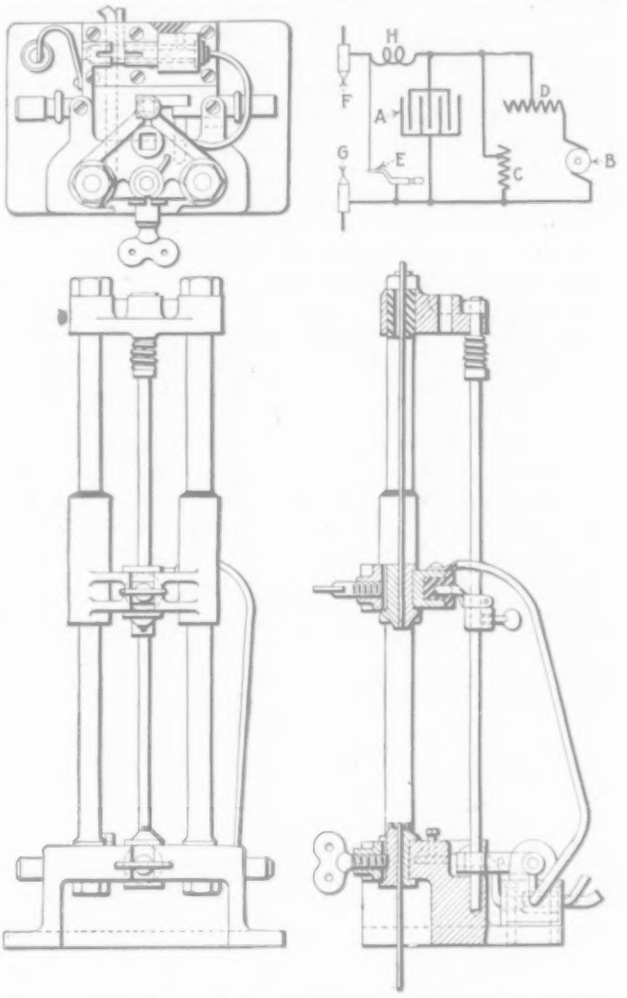


FIG. 2. DETAILS OF PERCUSSIVE WELDING MACHINE AND WIRING DIAGRAM

Each chuck is connected by flexible cable to a circuit as shown in Fig. 2. An electrolyte condenser *A*, shown in the wiring diagram, is connected across a source of direct current from *B*, which charges it to a potential determined by the resistances *C* and *D*. A switch *E* keeps the chucks *F* and *G* at the same potential during placement and removal of work.

After the wires to be welded have been chucked, they are clipped short by a cutter which gives each a chisel, or wedge-shaped end. These ends are set at right angles to each other. The switch is opened and the sliding chuck is released and allowed to fall. At the instant when the two narrow edges come into contact, the current discharged generates intense heat at the center of the section. The metal melts and is forced out by the impact and eventually the entire surface of each wire

is melted. Due to the very large body of cold metal adjacent, the thin film of molten metal solidifies quickly and since it is under momentarily heavy pressure it forms a homogenous mass absolutely continuous with the wires on each side. In practical operation, the inductance *H* is required to lower the rate at which the condenser discharges, that is, to maintain the current at a lower rate until the entire surface of the weld has been forced into contact. The correct action can be told by the sound made by the contact. It should be a splash or thud, rather than a sharp crack. The mass and drop of the falling part must be great enough to slightly forge the material. Once set for the proper drop, the machine will make a perfect weld every time.

Actual tests on two No. 18 B. & S. aluminum wires, using an oscillograph, show that the power being expended at the weld reaches a value of 23 kw. for an instant. However, the entire weld is made in 0.0012 sec., and the total energy used at the weld is 0.00000123 kw.-hr. The cost of this weld, figured at 10 cents per kw.-hr., would be twelve millionths of a cent.

A chart of the oscillograph aluminum-wire test just referred to, is shown in Fig. 3. At *A* the right-angled chisel-ends are shown almost in contact as the upper chuck falls. As the ends contact at *B* the voltage drops as indicated by the curve *G*, but the current and power consumption suddenly increases as shown by the curves *H* and *I* respectively.

At *C* the wire ends have separated, caused by the melting and vaporizing of the chisel edges. At *D* the chucks are closer together but the arc is still burning away the wire ends. At *E* the second contact has been made, the arc eliminated and upsetting begun. At *F* the weld is shown completed.

One of the principal uses for this process is in welding copper to aluminum, as for example copper lead-

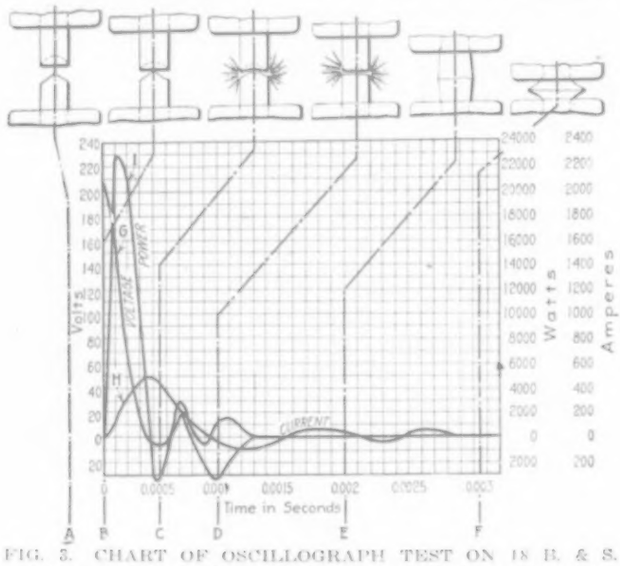


FIG. 3. CHART OF OSCILLOGRAPH TEST ON 18 B. & S. GAGE ALUMINUM WIRE, SHOWING POWER CONSUMED AND TIME TO COMPLETE A PERCUSSIVE WELD

wires to aluminum coils. The advantage of copper for connecting is self-evident, as it is easily soldered. It was thought at first that a weld of the two metals would result in a brittle point, but tests show that after several years the joint is apparently as strong and ductile as when first made. Similar ductility has been noted in almost every combination of metals when first welded, but disintegration and loss of ductility eventually result

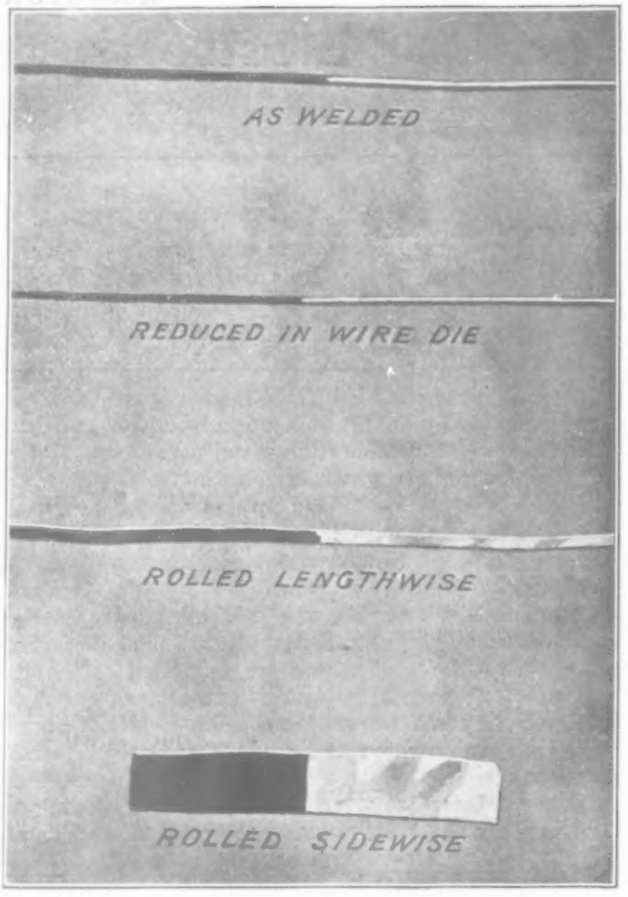


FIG. 4. COPPER WELDED TO ALUMINUM

in such welds as silver to tin or aluminum to tin, the welds being affected by what is known as "tin disease" or "tin pest"—a disintegration of the molecules.

Alloys of practically any composition can be welded to each other, and there is little diffusion of one metal into the other across the welded surface. Thus this method is quite suitable for *attaching contact points to flat plates* and making small welds required by jewelers.

Another important quality of the process is that metals which soften with heating, such as hard-drawn copper and silver, can be welded without change of condition since the length of metal heated to an annealing temperature will not be more than 0.004 in. long and this amount of metal is negligibly small. As will be seen from the specimens in Fig. 4, which show copper welded to aluminum, then drawn and rolled, there is no loss of ductility at the weld and no tendency for the two metals to separate.

Making Difficult Duplicate Gages

BY J. MAY
London, England

In the article published on page 706, Vol. 50, on the above title, would it not be much simpler to calculate the projection of the measuring ball above the top surface of the ring gage as follows (using the letters on the sketch).

$ce = Rcd \quad a; \quad co = \frac{R}{\sin a}; \quad cf = co + r; \quad ef = H = cf = ce.$

I might add that in using this method I have found it very convenient to use a ring slightly thicker than the distance *H* and use it in conjunction with a depth micrometer.

Conservation of Tin in Bearing Metals, Bronzes and Solders

By G. K. BURGESS and R. W. WOODWARD
Physicist and Assistant Physicist U. S. Bureau of Standards.

Alloys containing tin are costly to make, owing to the prevailing high prices of that metal. Experiments carried out with the view of tin conservation in bearing metals and solders have shown that in many cases either lowering the tin content per se or by the substitution or addition of other metals will not render the alloy less fit for its intended use. This article treats of alloys for various uses and gives some formulas for their modification that show decided conservation of tin in their composition.

FROM a metallurgical standpoint there are several ways in which a reduction of the tin consumed in commercial nonferrous and white-metal alloys can be effected: First, a reduction of the tin content of the alloy; second, substitution of part or all of the tin content by some other metal; and third, a substitution of a different type of alloy, which in some cases also involves a change in mechanical design. The Bureau of Standards has been studying these methods of conservation for tin alloys, particularly in regard the babbitts and bearing metals, bronzes and solders.

Much of the information secured by the bureau was obtained from answers to questionnaires sent to manufacturers and users of these materials, therefore, in general, any suggestions or recommendations made can be considered as being practical and as having already been thoroughly tried.

Bearing Metals

There is no question but that the tin content of nearly all bearing metals can be reduced to some extent, and in some cases actually eliminated, without prejudice to the service rendered. So the problem is to determine what needs are the most exacting or when a breakdown would cause the greatest damage and confine the use of high-tin babbitts to these uses only. Thus the main bearings of airplane and military automobile engines, turbine shafts, etc., will probably have to continue to use high-tin babbitt with a tin content of from 84 to 91 per cent. A babbitt metal such as S. A. E. specification No. 24, containing 84 per cent. of tin, 9 of antimony and 7 of copper, appears to be as satisfactory in service as genuine babbitt—89 per cent. of tin, 7½ of antimony, and 3½ of copper—or that specified by the International Aircraft Standards Board—91 per cent. of tin, 4½ of antimony, and 4½ of copper; but it should be pointed out that the latter two compositions are more fluid in the molten condition than the first named and consequently the lining can be made in a thinner shell with these babbitts, and the total amount of tin consumed may therefore be less than if the S. A. E. No. 24 were used. However, if the design of the bearing is not altered to admit of the thinner shell, the lower composition babbitt should be used in general.

TABLE I. SUBSTITUTES FOR GENUINE BABBITT

Ingredients	No. 1 Per Cent.	No. 2 Per Cent.	No. 3 Per Cent.	No. 4 Per Cent.	No. 5 Per Cent.	No. 6 Per Cent.
Tin	65	62	8	5	10	21.3
Antimony	...	..	8	7	12.5	...
Copper	3–6	4	4	2	0.5	3.0
Zinc	28–30	33	...	76	....	63.3
Aluminum	.....	1	...	...	.....	....
Lead	.....	....	80	10	77	12

The compositions given in Table I are also recommended for use where a high-grade lining is required and where a genuine babbitt is often now used.

Nos. 3 and 4 have been found to do the service required of tin base linings in machine-tool bearings. No. 5 can be used on similar bearings where a greater strain is met. No. 6 is in use in Germany as a "best" babbitt to conserve both tin and copper.

For linings on railroad-truck journals two compositions are in general use, one composed of 85 per cent. of lead, 10 of antimony, 5 of tin, and the other of 87 per cent. of lead and 13 of antimony. The latter is restricted by some roads to freight service and the former used on passenger equipment. Many roads, however, use the 87 per cent. of lead and 13 of antimony on both classes of service, and it seems that its use might be made more universal.

Another type of lining metal which deserves serious consideration is one composed almost entirely of lead, with small additions of alkali or alkali earth metal. Certain of these have been given service tests at the Bureau of Standards and in many respects were found equal to or superior to genuine babbitt.

Table II gives a summary of the tests on the metal and similar tests on genuine babbitt of composition 89 per cent. of tin, 7½ of antimony and 3½ of copper.

TABLE II. SUMMARY OF TESTS ON GENUINE BABBITT AND ALSO HARD METALS

Load, Lb. per Sq. In.	Revolutions per Minute	Total Number of Revolutions	Final Temperature °C.	Final Temperature °F.	Rise in Temperature °C.	Rise in Temperature °F.	Friction, Lb.	Loss in Weight, Grams	Remarks
Genuine Babbitt									
100	694	12,230	89	192	53	95	22	0.023	
200	706	16,510	102	216	58	104	29	0.021	
300	682	15,150	125	257	100	180	38	0.013	Belt slipping
400	603	6,600	139	282	94	169	79	0.054	Bearing seized and smoking
Ulco Hard Metal									
100	710	13,160	56	133	23	41	13	0.013	
200	715	18,870	69	156	33	59	18	0.021	
300	719	18,830	80	176	42	76	27	0.013	
400	711	17,310	81	178	43	77	23	0.022	
500	723	17,600	79	174	43	77	25	0.014	
600	692	14,960	84	183	45	81	24	0.021	
700	648	24,520	62	144	38	68	24	0.020	
800	365	12,870	53	127	20	36	23	0.010	
900	408	22,300	59	138	22	40	24	0.015	
1000	405	23,200	66	151	36	65	22	0.014	Bearing still in good condition

Large quantities of phosphor bronze of the composition 80 per cent. copper, 10 lead, and 10 tin, and deoxidized with phosphorus, are used in unlined bearings at fairly high speeds and pressures. The compositions in Table III have been suggested as substitutes for this composition, although it is our opinion that

trouble will sometimes be experienced with Nos. 8, 9 and 10 because of the high lead content, and they have about the same tin content as the others in the list.

At a meeting called by the conservation division of the War Industries Board on Apr. 15, 1918, which was attended by manufacturers and users of bearing metals, the Bureau of Standards was requested, after a conference with technical representatives of the large manufacturers and users, to determine if four classes of babbitt metal could be adopted ranging in tin content as follows: Class A (genuine babbitt), 89 per cent. tin; Class B, 40 to 50 per cent. tin; Class C, 4 to 6½ per cent. tin; Class D, containing no tin.

The bureau has gone over the situation with several of the representatives as noted above, and the general opinion seems to be that it is impossible to limit some of the classes to a single composition, because of the fact that several compositions of nearly the same tin content are in general use for different purposes. Thus, in Table IV, No. A1 is used in aircraft engines, No. A3 is used for automobile engines, and No. A4 is found in bearings of electrical machinery. It was thought,

TABLE III. SUBSTITUTES FOR PHOSPHOR BRONZE

Ingredients	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12
Copper	81	79	74	64	Remainder	Remainder
Tin	7	5	5	5	8	5
Lead	9	15	20	25	15	17.5
Zinc	3	....	....	....	1.5–3	5
Antimony	....	....	....	5	....	....
Phosphor copper	....	1	1	1	....	....

however, that Class B can be entirely dispensed with, as these intermediate tin-content bearing metals are in no way as satisfactory as either a high-lead or high-tin base babbitt. In all cases where Class B could be used, Class C or Class D will be found to serve the purpose equally as well. There are, however, some grades of babbitt containing about 65 per cent. tin which do not fall into either Class A or Class B, but which are often claimed by the manufacturers to equal the high-tin babbitt in performance. If these claims can be substantiated, this babbitt should be considered as falling into the category of Class A and as being a substitute for alloys in that class.

It should not be presumed that because high-tin babbitt of Class A is included that the bureau recommends the continuance of its use for many bearings in which it is now used. The lowest possible tin content alloy should always be used, and the bureau believes that it might be advisable to have some central body issue licenses for the use of babbitt in Class A in order to insure that no Class A babbitt is being used where others are satisfactory.

Alloy D2 has been included in Class D because this comprises babbitt metals containing no tin. It should be noted, though, that this alloy will be found satisfactory in many installations where Class A has hitherto been used, and its inclusion in Class D should not give the impression that it is a low-grade babbitt.

The American Society for Testing Materials has drawn up specifications for 12 compositions of babbitt metals (B23-18T) which, however, do not take into consideration the factor of tin conservation, but are formed for use in peace times. The present recommendations are for use in the existing situation where the saving of all tin possible is of prime importance.

The recommended compositions for the various classes are given in Table IV. These compositions have been selected so as to include existing specifications and usage of babbitt metals as far as possible. Much information has been secured from the questionnaire sent out by the bureau and from replies to the general letter issued by the War Industries Board on May 29, 1918.

Passing now to the bronzes other than those used for bearing purposes, we find that "government bronze" (Navy Specification 46M6a, gun metal) of 88 per cent. copper, 10 tin and 2 zinc, is used in large quantities and can also be modified to admit of a saving of tin without impairment of the physical properties sought. Experiments by the Bureau of Standards and others

TABLE IV. BEARING METALS WITH LEAST TIN CONTENT

Class	No.	Tin, Per Cent.	Antimony, Per Cent.	Lead, Per Cent.	Copper, Per Cent.	Iron *a*	Arsenic *a*
A	A1	91	4½	*a*1.00	4½	0.08	0.10
	A2	89	7½	*a*1.00	3½	0.08	0.10
	A3	84	9	*a*1.00	7	0.08	0.10
	A4	83	8½	1.00	8½	0.08	0.10
C	C1	5	10	85	*a*50	....	0.20
D	D1	....	13	87	*a*50	....	0.25
	D2	Lead about 98 per cent., balance alkali and/or alkali earth.					

a Maximum.

have shown that a composition of 88 per cent. copper, 8 tin and 4 zinc, is equal to or superior to the ordinary government bronze. Aluminum bronze of composition 90 per cent. aluminum and 10 per cent. copper, for example, can also be substituted for many uses of government bronze, as can also manganese bronze and naval brass. There have also been introduced several aluminum bronzes containing small amounts of iron, which can be either cast or wrought and which are now being used by several former users of government bronze.

Some manufacturers have raised an objection to using aluminum bronze because the scrap accumulating from this alloy, if it gets mixed with other metals, particularly valve metals, would have a deleterious effect upon them. This is simply a problem in works management of properly sorting and routing scrap. We know of several large manufacturers who make aluminum-bronze

TABLE V. PROPERTIES OF ALLOYS FOR OTHER THAN BEARING PURPOSES

Alloy	Tensile Strength, Lb./In.²	Elastic Limit, Lb./In.²	Elongation in 2 Inches, Per Cent.	Authority
Government bronze, 88 Cu, 10 Sn, 2 Zn	38,860	12,250	25.2	Average of 30 tensile specimens poured in 5 different foundries. Tensile tests made at the Bureau of Standards.
88 Cu, 8 Sn, 4 Zn	39,220	11,000	30.6	Same as above, except that it represents only 26 specimens.
Aluminum bronze	71,000	25,000	21	Corse & Comstock, Trans. Soc. Autom. Eng., 1916, Part II, pp. 272-273.
Manganese bronze, U. S. N., Mn	70,000	35,000	30	Navy Department specification 46B15.
Naval brass	*a* 54,000 *b* 60,000	25,000 27,000	40 35	Navy Department specification 46B6b.
Aluminum bronze with iron (Sillman bronze):				
Wrought alloy *c*	84,400	14,000	11.5	Bureau of Standards test.
Cast alloy	78,850	11,500	14.5	Bureau of Standards test.

a Over 1 in. *b* Below ½ in. *c* Chemical composition: Cu, 86.4 per cent., Al, 9.7 per cent.; Fe, 3.9 per cent.

castings in the proximity of steam metal castings and who by taking the proper precautions have encountered no difficulties.

Table V gives some of the properties of the above-mentioned alloys.

At the suggestion of the Imperial Electric Co. of Akron, Ohio, the bureau also made tests on government bronze in which one-half of the tin was replaced by an equal amount of nickel. The averages of several tests on these alloys are shown in Table VI.

It will be observed that these values are exceedingly good for this class of material and that either of the alloys can be used as a means of conserving tin.

Many small machine-parts castings are made of bronze, which can just as readily, or even sometimes better, be manufactured of a brass composition—i.e., copper-zinc alloys. Tin is also looked upon in many brass foundries as a "cure-all" for poor castings and is often added to the mixture when trouble is encountered. This practice is not only questionable and should not obtain in brass foundries, but the cause of the poor castings should be determined and the proper remedies applied in a regular manner.

The composition of soldiers will vary with the use for which the solder is intended. Formerly, every mechanic believed that nothing was as good as "half-and-half," or 50 per cent. tin and 50 per cent. lead solder. There are very few cases where a 50-50 solder is necessary in the present emergency; its use should be eliminated. No solder over 45-55 should be used for hand soldering with the iron and in the majority of cases 40-60 will serve the purpose. Most plumbers use 40-60 for making wiped joints, whereas 37½-62½ is for all such purposes just as satisfactory. Up to 1½ per cent. of the tin in a wiping solder can be replaced by antimony, although this element is objectionable if present in solder for other purposes.

TABLE VI. TESTS OF BRONZES ALLOYED WITH NICKEL

Composition	Ultimate Strength, Lb./In.²	Yield Point, Lb./In.²	Elongation in 2 In., Per Cent.	Reduction in Area, Per Cent.	Modulus of Elasticity Lb./In.²
Cu 88, Sn 5, Ni 5, Zn 2	40,680	13,050	31.8	28.0	17,300,000
Cu 89, Sn 4, Ni 4, Zn 3	39,675	11,500	31.2	31.2	14,900,000

In the manufacture of automobile or airplane radiators very little solder need be used of greater tin content than 40 per cent., and in many cases 35-65 or lower is being used with success. For the canning industry, both in the manufacture of the can and in its sealing, 37½-62½ solder can be used with satisfactory results. Articles which are tinned previous to soldering can be "tinned" in a bath composed of the eutectic of tin and lead—63 per cent. tin and 37 per cent. lead. This composition will be found to be fluid and will not segregate, as will certain other tin-lead baths.

Cadmium as Tin Substitute[1]

Cadmium appears as a promising substitute for part of the tin in solders. The bureau has been developing such a solder, and laboratory tests, together with manufacturing experience, so far point to a composition of 80 per cent. lead, 10 per cent. tin and 10 per cent. cadmium as being practicable for many of the purposes for which solder is required. This solder has been tried in the manufacture of tin cans, on roofing materials, and for electrical joints, with encouraging results in all cases. Before using it for food containers, however, it will be necessary to ascertain its toxic properties under various conditions. A test has also been made of it in the manufacture of automobile radiators with most satisfactory results.

The tensile strength of the cadmium solder is about the same as that of 40-60 solder, but the ductility is approximately twice that of the ordinary solders. The point of complete liquidation is only slightly higher than that of the ordinary composition of solders, while the range of solidification is considerably greater. Table VII gives some of the provisional data on these solders as compared to the tin-lead solders. The tensile properties given are the average of four determinations and were made on a Scott testing machine, the rate of separation being about 12 in. per minute.

TABLE VII. PHYSICAL PROPERTIES OF CADMIUM-LEAD AND TIN-LEAD SOLDERS

	Initial Solidification °C.	Secondary Solidification °C.	Final Solidification °C.	Specific Gravity	Equivalent Volume to 1 Volume 50-50 Solder	Tensile Strength, Lb./In.²	Elongation in 2 In., Per Cent.
50 per cent. tin and 50 per cent. lead	*a*210	*a*181	*a*149	8.81	1.00	5698	20.3
40 per cent. tin and 60 per cent. lead	*a*238	*a*181	*a*149	9.47	1.07	5820	26.0
37½ per cent. tin and 62½ per cent. lead	*a*245	*a*181	*a*149	9.54	1.08	5383	28.8
90 per cent. lead and 10 per cent. cadmium	*b*267	....	*b* 249	11.09	1.26	5000	37.5
80 per cent. lead, 10 per cent. cadmium, and 10 per cent. tin	254	183	143	10.35	1.17	5727	52.3
85 per cent. lead, 10 per cent. cadmium, and 5 per cent. tin	257	202	141	10.67	1.21	(*c*)	(*c*)
75 per cent. lead, 10 per cent. cadmium, and 15 per cent. tin	(*c*)	(*c*)	(*c*)	10.26	1.16	5880	41.7

a Rosenhain and Tucker, Phil. Trans. A. 209, p. 89; 1918. *c* Not determined.
b Kapp, Drudes Ann, 6, p. 754 (1901).

Because of the preponderance of lead in the cadmium solder, the price of it is very reasonable; with the present market prices of the metals involved it is thought that the 80-10-10 solder can be sold at a profit of 35c. a pound. It is also thought that plenty of cadmium can be produced as soon as the market for it is created, as there are undoubtedly available American sources of cadmium which are not at present exploited.[2]

In meetings with manufacturers of materials containing tin it is always brought out that the Government is the worst offender, and that many Government specifications often call for a lavish use of tin which is sometimes detrimental to the quality of the material manufactured. We believe, however, that many of these specifications are being revised in order to conserve tin, but that there is still room for further improvement. As a means of conserving the use of tin by the Government, we would suggest the advisability of creating a joint committee of technical representatives of the various departments to pass upon or revise all Government specifications containing tin. Such a committee could be in close coöperation with the manufacturers and would form a better means for the manufacturers to criticize the tin content of Government specifications than now exists in any of the departments.

"Finding One's Place"

By James Leslie Lane

Fortunate indeed is the engineer who finds, after several years of work, that the field he has chosen or been thrust into by circumstance is the one best suited to his talents. All too frequently he discovers, when too late, that he is better fitted for some other line. As a result he flounders around in a quandary for a time, then either abandons the profession entirely or

[1] For most of the experimented data on cadmium solders the authors are indebted to L. J. Gurevich of the Metallurgical staff of the bureau.

[2] See C. E. Siebenthal, Cadmium in 1917, Mineral Resources of United States, Pt. I, p. 49-53; 1917.

continues to plod on, all his early eagerness and enthusiasm for the work gone.

Such a condition is due less to a faulty educational system than to one's inability to determine at the outset just what he is best fitted for. Most young men enter upon the training for a professional career at the age of 18 or 19 and, as this is too early for any particular leanings to have asserted themselves, their choice is made more or less at random.

Why Boys Become Engineers

As a rule they know at this time whether or not they prefer engineering to medicine or law, but the particular branch of the former their choice happens to single out is mainly due to chance. A story read during high-school days, whose hero was a bridge builder, may lead them to choose civil engineering; a boyish fancy for Steinmetz or the mysteries of the wireless may sway them toward electricity; or again the deciding factor may be parental in its nature. Whatever the reason may be, the fact remains that, once the choice is made, it is difficult to change.

After spending two years in mastering the basic studies, physics, mathematics, etc., that underlie all engineering work, and then a period of at least two more in specialization, the student shrinks from the thought of casting aside all this preparation and beginning anew. Not only is the additional expense of such a course prohibitive but he has reached the age when rigorous collegiate work has become irksome. His companions are ready to make their own way in the world and he wishes to do the same. Besides, he has been so intent on the theoretical side and so out of touch with the practical that he has had little or no leisure to consider his especial fitness for the calling.

Only after he has taken his degree and has spent a few years on the board, at estimating, at time study or shop work, is he able to tell just what his real abilities are; whether or not his natural talents are well suited to the field he has chosen. If they are, and he finds himself content to go on, he is to be congratulated on his good fortune. Far more often on reaching this stage a man finds that he possesses ability for which the work he has chosen offers little or no scope.

Engaged in general engineering practice, he may discover, quite by accident, that he does best when assigned to research work or to the designing of machinery for some new and special purpose; that while he is more or less indifferent to routine duties he becomes deeply absorbed in this class of work and produces excellent results. Then, for the first time, he begins to ponder what he shall do.

Finding an Opportunity

If the company he is connected with is large or progressive enough to offer steady employment along this line, the solution is an easy one. He has merely to apply himself to the solution of these problems and to show, by concrete results, that such work is to their interest financially. The opportunity is at hand; he has merely to demonstrate his fitness for it. However, should such problems be merely incidental to their line, he is faced with two alternatives—either to adjust himself to routine work that is not to his taste, or to strike out for himself in an attempt to find a place where he can exercise his talents to the best advantage.

Generally, the latter course requires a great deal of courage. Three or four years spent in the line he has chosen have made him valuable enough to command a fair salary and he hates to lose this by beginning over. All his acquaintances in the business world have been made through daily contact with men in this field. They are an asset, in both a social and business way, and he hesitates to cut loose from them. Whichever way he looks he finds himself anchored to his old place by bonds that are exceedingly strong, even if intangible. Besides, the giving up of this work will appear, he is apt to feel, a tacit acknowledgment to his friends that he has been a failure. Not knowing his real purpose they can only draw their own conclusions and he shrinks from changing.

Some day when the psychologists have developed the art of vocational selection to a point where it is thoroughly reliable, and its use widespread, humanity will be saved many thousands of misspent years. Until that time comes the young man who finds himself out of place must do what he can to correct the evil by himself.

Nor is the task an easy one. So far the only result of his work has been to convince himself of his real ability along a certain line. Convincing other people is a far more difficult undertaking.

To begin with, he must first convince himself that his desire for a change is something more than a passing fancy. The best way to do this, and at the same time to make a beginning, is to look about for something to do in the designing field in addition to his office duties. He is like a barrister seeking to build up a practice and must take whatever comes his way, no matter how trivial it may be. Many a young lawyer has made his reputation through the brilliant handling of a case that others scorned to bother with, and he must do the same.

Making a Start Is Slow Work and Poor Pay

Money should be a secondary consideration; his only object being for the present to demonstrate his ability. The chance may be long in coming; perhaps only a job of tracing for some busy engineer who has not the necessary staff to get it out in time, but he should take it even though it be a class of work he considers beneath him. Let him set up a board in his room and do the job so thoroughly that an impression is made on the man having it done.

If by so doing he makes a new business acquaintance it will be worth all the effort cost; certainly, far more in the end than the small amount of money he will receive. Better jobs, bigger opportunities, come to us only through being known. No matter how brilliant a man may be it will avail him nothing unless people know about it.

The results of close application to such tasks will soon be apparent in more ways than one. Business acquaintances pyramid rapidly. Let each satisfied client not only come back a second time but recommend him to another, and he will soon find himself getting all he can attend to. If he really possesses a mind fitted for original work, a few months of application to such effort will show it. At the end of this time he should have done enough to warrant his going to some firm with a strong research department, and seeking a regular position with them. If he has attacked this preliminary work in the right spirit he will have made his own opportunity, will have something tangible to show, and plenty of men to recommend him. The rest will depend, in a large measure, on hard work and natural aptitude.

A Group Tool Storage System

By PETER F. O'SHEA

Human card indexes for keeping track of tools may cause endless trouble in a plant which was hit by the draft and faced by the introduction of new lines of work, as in this case. The method used to surmount the difficulty and at the same time improve on the time-honored custom may offer valuable suggestions to other sufferers.

IT HAS been a common thing in long-established shops for some of the processes, the kind of tools required and the location of the tools, to be recorded in the heads of the individual workmen. But when the war came it made revolutionary changes in personnel, taking away many men who had served as memorandum pads on important jobs and revealing to factories all over the country the weakness of the personal method of storing knowledge, specifications, processes or tools.

This problem was specially emphasized in one plant of the Greenfield Tap and Die Corporation by an event that happened simultaneously with the war. A line of cutting-off machines and saw sharpeners which had formerly been made at the recently purchased Nutter & Barnes plant, Hinsdale, N. H., and a line of bolt cutters which had been made at another of the corporation's plants were both moved to the machinery division, augmenting the line already there.

In the manufacture of machines, tools, jigs and fixtures are important. During the years, as the moving pictures say, the men in each line from experience had learned just what tools were needed on each part of the job, where they could be found and on what process and part they were used. Then three lines of work went along side by side and the tools became mixed. Of course workmen from the two outside lines came in to the new plant, but some of them were taken by the draft and their places had to be filled by men transferred from another part of the shop.

As this process promised to go on until the end of the war it became necessary to arrange things so that old acquaintance did not count. With regard to tools the problem was solved by the new tool crib shown in Fig. 1.

In a machine shop a great many tools and fixtures accumulate which have been specially designed for particular operations. Sometimes they are superseded by other tools and become obsolete, or some oddly shaped tool made for a special purpose may be so rarely used that it was not known just what it was for. Fixtures for holding work on milling or drilling tables must often be designed to fit one job, but several such fixtures may be much alike in general appearance so that they cannot be distinguished at a glance.

In this plant the problem was attacked in this way: First, one competent man gathered definite information of the purpose of each tool, jig or fixture in the factory. Then he grouped all the tools, jigs and fixtures designed for use on one part of a product; for example, all the tools used in making a certain kind of vise head.

FIG. 1. ARRANGEMENT OF RACKS IN TOOL CRIB

These tools were then stored in one compartment of the crib so far as possible. Convenient groups of small tools were stored in trays or sheet-metal boxes, as illustrated in Fig. 3, which shows such a box containing tools Nos. 55, 56, 57 and 58, the first three being used in machining the head of an automatic turret and the last being a spiral thread gage for the stud of the same turret.

When a workman gets an order to make a certain part of a machine he applies to the clerk of the tool crib, who at once hands him out from the proper compartment all the tools he will need for the job on that part.

In order to do this it is necessary to keep a small card index, and to designate by numbers or letters the tools, the racks and compartments

and the jobs or parts of the machines manufactured.

The racks from left to right are plainly numbered on the ends toward the aisle. They are grouped by twos back to back with a passageway between each pair. The first and last racks, which are single, back up to the opposite walls or partitions of the crib inclosure.

Enough vertical partitions to give strength divide each rack into bays which are designated by capital letters printed on the side of the partition so that they are visible from the aisle. The compartments in a bay are numbered from the bottom up. The racks go clear

Tool No.	Location	Part where used
352	1-C-6	190/80
	Description	
Jig for drilling top end of new No. 190 Grinder Standard.		

FIG. 2. TOOL IDENTIFICATION CARD

to the roof and are served by ladders which are supported on a trolley wheel on T-rails attached to the ceiling and roll in or out of each alcove.

Each tool, jig or fixture is given an individual identification number, which is either stamped on the tool or is on a metal tag screwed to it at some place near the front corner. For each tool there is a card, Fig. 2, and at the top at the left is the identification number of the tool. The location is then recorded by the number of the rack, the letter of the bay and the number of the compartment in which the tool will be found. The product and exact part of the product on which the tool is used is designated by a fraction at the right, the numerator being the catalog or specification number of the completed product machine, and the denominator being the blueprint or part number of the detail part of the product.

Finally there is a brief description of the tool and its purpose plainly typewritten across the middle of the card. These cards are filed for ordinary reference by the job number on the right corner.

When the numbering was first done successive numbers were naturally attached to the tools in the same group because they happened to be at hand in the course of the rearrangement, but no effort was made to do this.

After many years of additions to the tools little correspondence will remain between the individual identification number of the tool and either the part on which it is used or the corresponding rack number where it is stored. Therefore to find the location of an individual tool a second index is necessary.

This cross-index is made by using cards which are duplicates of those in the other index, but filing them by the identification numbers at the left corner.

If an individual tool has strayed from the others its proper place can be immediately found by this cross-index. These two files are kept in the tool crib on the clerk's desk. To provide against loss of cards a master ledger is kept in the office as a record, from which a card may be replaced correctly.

Although the general plan is to store all tools used on the same job in the same compartment exceptions are made to this. If, for instance, jigs of a group are too big to go into the compartment with the rest they are put below in a compartment at waist height in the same tier or bay of the rack. These waist-high compartments, it will be noticed, are larger than the others and permit storing large and heavy pieces at the most convenient level for lifting.

Very heavy fixtures for certain jobs frequently performed are kept on wheels and trucks specially made for them and used for nothing else. The space which

FIG. 3. TOOL-CRIB DOOR AND WICKET

would correspond to the lower compartment of each rack is not shelved but is left clear for the storage of the trucks and fixtures when not in use, so that when the fixture is wanted again it does not take three or four men a half hour to lift it out or in.

The general plan of the distribution of the tools into racks is to reserve one rack for tools used on each one of the three component lines of products mentioned. Thus the farther bays of rack 1 and rack 2 are devoted to fixtures, tools and jigs for milling and drilling operations on parts of the F. E. Wells line. The inner bays of rack 3 and all of rack 4 are devoted to other work on the F. E. Wells line. Rack 6 contains all the tools used in making parts for the bolt cutters. Racks 5 and 7 contain tools for the new Nutter & Barnes line of cutting-off machines.

Obsolete tools are kept in rack 8 without any attempt at arrangement by part or by process; in fact they are not even numbered. By obsolete is meant tools that may never be used again except for repair parts for machines sold years ago.

Several exceptions are also made in the general plan of reserving the whole of one rack for tools of a given line. The nearer bays of racks 1, 2 and 3 adjoining the door are used for storing shop tools frequently used. Here files and other standard tools are ready for the hand of the tool-crib clerk for delivery at the window. This is the reason why only the inner ends of the first three racks are used for special jigs and fixtures.

A small work bench carrying a vise is discernible in Fig. 1 across the aisle end of the second and third racks. It will be noticed that these two racks are shorter than the others to give room for the bench without encroaching on the aisle space.

Miscellaneous factory supplies are kept on the top shelf of rack 7. This is the least readily accessible part of the room and the proper place for supplies which are not often called for and is another exception to the general rule of apportioning racks according to the products, line and parts.

The Belt Rack

The belt rack, Fig. 4, with each size of belt wound in a roll on a spindle is put on the farther wall of the crib opposite the end of the aisle space and facing the door. Thus if a piece of belting is called for the clerk may catch hold of the end of the proper roll and pull it out

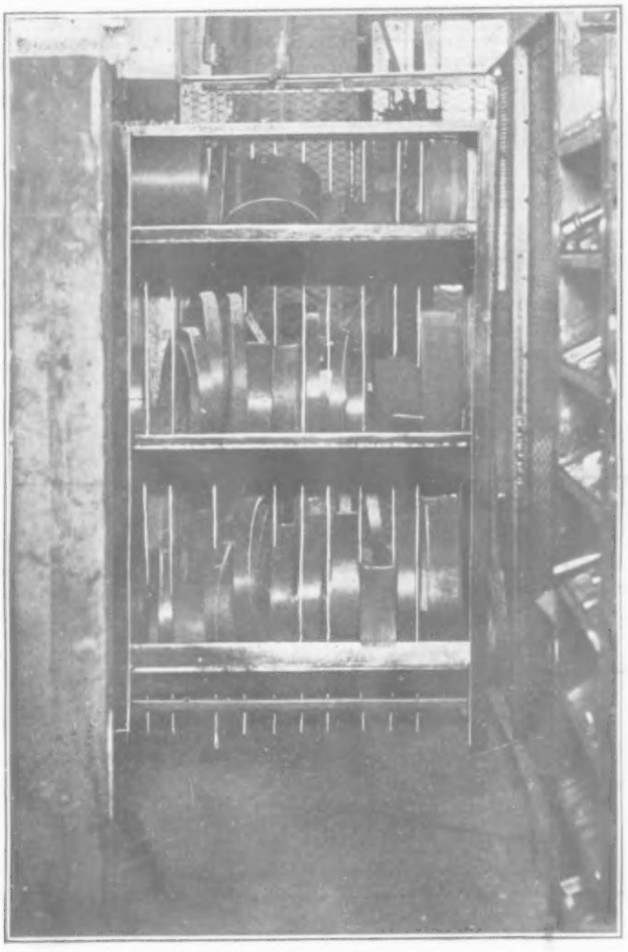


FIG. 4. BELT-STORAGE RACK

along the floor of the aisle space or beyond through the open doorway into the shop if necessary. The whole tool crib is so compact that at first sight it seems to have no free space, but this arrangement leaves plenty of room for quick work.

In the part of the tool crib across from the special tool rack are six other racks of shoulder height on which shop tools such as drills and arbors are laid out in series, according to size. Drills take up two racks, arbors another and reamers still another. The bed of each compartment is gouged out or is divided by projecting slats inserted edgewise to make small subdivisions as wide as the diameter of the tools. The beds of all these compartments slant backward and upward so that the drills and arbors are presented for immediate selection according to the proper dimensions stamped on the shank of each tool.

The tool clerk's desk is directly at the left of the door so that he may stand and do his recording work without being far from the window. The wicket in the door is simply a hole shaped in the woven wire and supplied with a sheet-iron shelf supported by a quadrant which is turned up along the edge of the door.

Sheet-metal semicircles or quadrants of woven wire are used as shields around the lock to make it impossible to reach through the wickets to open the lock. They also protect the lock from being picked or otherwise opened from the outside by any method short of a battering ram. With these shields on the door no one can walk into the racks themselves.

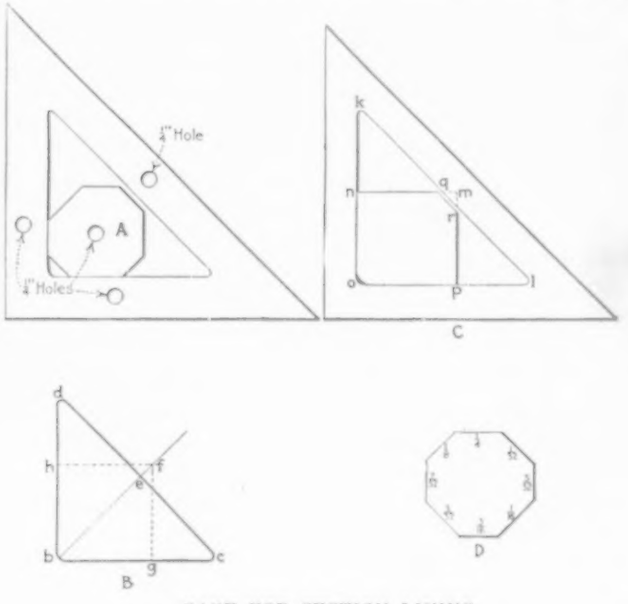
When an employee leaves a new man can go to the tool crib and instantly have the proper tools for his job delivered to him. The method also saves time for the old employees, as they do not have to stop to recollect where the tools are or which are needed or to go back for tools they forgot to take.

Section-Lining Kink

By S. B. Royal

A simple way of converting a triangle into a section-liner is by the use of the inside gage shown in the illustration. This may be made of any stiff material, but a piece of celluloid from an old triangle is preferable because of its transparency. A ¼-in. hole is drilled in the center of this piece *A*, and ¼-in. holes are drilled in the center of each side of the triangle.

To operate the device one finger is placed in the hole that is at the lowest part of the triangle (depending



GAGE FOR SECTION LINING

upon which way the latter stands) and the next finger in the hole in the piece *A*. By moving the fingers alternately, the triangle will move away from a given line a specific distance each time, thereby producing the divisions desired for section lining. It is not intended to have the fingers go into these ¼-in. holes; they are merely to break up the smooth surface and provide a hold for the finger tips.

With a center piece as shown, eight different spacings may be obtained which may be made to suit the individual. The writer used divisions of 1/32, 1/16, 3/32, ¼, 5/32, 3/16, 7/32 and ½ inch.

The method of making the piece is as follows: Trace around the inside opening of the triangle which gives a triangle with round corners as shown at *B*. Draw a line *be* extending it to make *ef*, equal to one-eighth the length of *be*. Then with *f* as a point, draw lines *fg* perpendicular to *bc* and *fh* perpendicular to *bd*. We now have the square *bhfg* which is the size of the square to be cut from the celluloid. This is shown at *C* as *mnop*. Lay the triangle on this square as shown and scratch along the side *kl* of the triangle on the square *mnop*. Measure from this scratch line along the side *mn* a distance of 1/32 in. and draw a line *qr* parallel to the original scratch line. Cut the corner of the square off on this new line.

Proceed in the same manner with the other four corners, only measure distances of 1/16, 3/32 and 1/8 in., respectively, instead of 1/32 in. We now have the octagon shown at *D*. The sides that remain of the original square will also serve as gages for sectioning, giving spacings of approximately 5/32, 3/16, 7/32 and 1/4 inch.

The method of construction described makes all of the sides of nearly the same length, giving equal bearing surfaces and a balanced appearance. It is advisable to mark each of the sides as shown with the width of section lining it will produce. These sizes may be scratched on, but are more neat if stamped on with a set of steel figures which are to be found in every toolroom.

Charts for Design of Tension Bolts and Screws

By Capt. H. M. Brayton

Practically all mechanical devices require bolts and screws in one form or another to hold them together. Sometimes these bolts are required to hold only the weight of the parts, or they may have to hold internal pressure, as in the case of the cylinder head on a steam engine, or they may be necessary to withstand inertia stresses in high-speed machinery.

Whenever a bolt is subjected to tension the engineer and designer desire to know how it will fail. There are four principal ways in which it can fail: (1) bursting

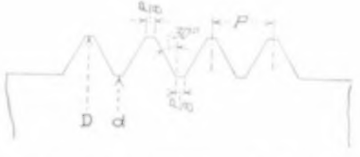


FIG. 1. PROFILE OF UNITED STATES STANDARD THREADS

of the nut; (2) failing of the threads by shearing; (3) failing of the threads by cantilever action; (4) failing of the shank by tension, causing rupture across the root diameter of the thread.

If the threads are properly proportioned on the bolt it will be equally strong in respect to all four of the above-mentioned methods of failure. This is what has been done in the United States Standard, the now almost universally adopted thread, the profile of which is given in Fig. 1. In determining the size of bolt having United States Standard threads, which it will be necessary to use to withstand a known stress, it is simply necessary to obtain the root area of the bolt and divide it into the total stress. This will give the fiber stress to which the

Outside Diameter of Bolt (D) in Inches
Fiber Stress (f1) Pounds per Square Inch, Thousands of Pounds
Threads per Inch (T)
Total Load on Bolt in Pounds (L)
D = 1.125 √(L/f1 + 1.30/T)
30°

FIG. 2. CHART SHOWING FOUR VARIABLES

steel would be subjected. The calculations for obtaining a relation between the outside diameter of the bolt, the total load, the fiber stress and the pitch of the thread or the number of threads per inch is very simple and is here given for the reader's guidance.

By referring to Fig. 1, the following nomenclature will be self-evident:

D = Outside diameter of shank, inches.
d = Root diameter of thread, inches.
P = Pitch of thread.
T = Threads per inch.
L = Total load, axially, on bolt, in pounds.
f_t = Fiber stress in pounds per square inch.

Then from the figure we have

$$\text{an } 30^\circ = \frac{\frac{1}{3}}{\frac{D-d}{2}} = \frac{\frac{P}{2}}{\frac{P}{8}} = \frac{3P}{4(D-d)} \qquad (1)$$

$$L = f_t \frac{\pi d^2}{4}$$

$$\text{from which } d = \frac{\sqrt{L}}{\sqrt{0.785\, f_t}} \qquad (2)$$

Then if we substitute this value of d as given in equation 2 into equation 1 we obtain

$$\frac{1}{\sqrt{0.785 f_t}}\sqrt{L} = D - \frac{3\sqrt{3P}}{4} = D - \frac{3\sqrt{3}}{4T} \text{ because } P = \frac{1}{T} \qquad (3)$$

Equation 3, then, shows the relation between the four variables referred to, and it is necessary for the designer to solve this formula when he desires to know the stress in a bolt. In order to save time and labor this formula can be easily built up into a simple chart

from which any one of the four unknown values may be read off at will when the other three are known. Such a chart is shown in Fig. 2, and covers a range of values usually met in everyday practice. The dash-dot lines are for the purpose of showing how to read the chart.

Assume that we desire to know what load can be withstood by a 1-in. bolt having eight threads per inch

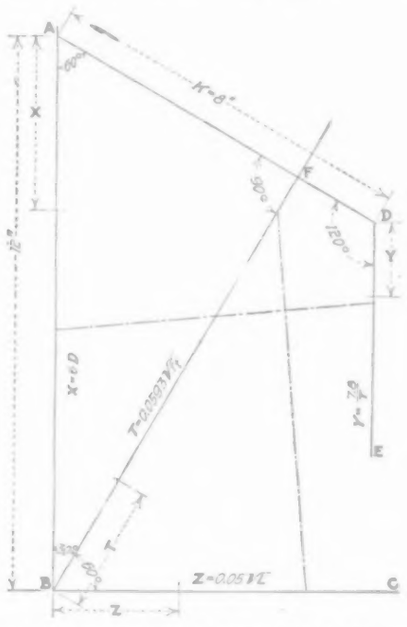


FIG. 3. DIAGRAM SHOWING HOW TO LAY OUT CHART IN FIG. 2

and an allowable fiber stress of 20,000 lb. per square inch. First we draw the line shown connecting the bolt diameter and the threads per inch, then draw from the fiber stress of 20,000 a line perpendicular to the first line until it meets the bottom scale representing total load. In this case we find that the bolt can withstand a load of about 11,000 lb. It is not necessary to draw these lines every time the chart is used. If it were the chart would soon get so filled with lines that it would be difficult to read. Simply make two perpendicular lines on a piece of celluloid or tracing cloth and use this to read the chart. This method will be found both quick and convenient.

Because of the importance of this formula to every engineer doing machine-designing work of any kind I believe the chart shown in Fig. 2 should be on every engineer's desk. The method of constructing the chart will be given to enable the reader to make one.

In Fig. 3 a diagrammatic layout is given. Simply reproduce this to scale. Then lay off along the various axes the equations given. For example lay off along the line AB from A in inches the value obtained for X when different values are assigned to D. Illustrating this assign to D the value 0.50 in. and we have for X the value $6 \times 0.5 = 3$ in. Measure off from A a distance of 3 in. and mark this point 0.50 in. Similarly when $D = 1$ in. we would have $X = 6 \times 1 = 6$ in., and we mark this point 1 in. In the same way we lay off the values of T, Y and Z as given by the equations shown on these lines in Fig. 3. Lay off T from B; lay off Y from D, and lay off Z from B. The limits chosen are given in Fig. 2.

In 1864 William Sellers proposed the following formula for the relation between the bolt diameter and the pitch:

$$P = 0.24\sqrt{D + 0.625} - 0.175$$

The radical in this expression made it difficult to handle, and the following simplified formula is in general use, although it is slightly in error either side of the 1-in. size:

$$P = 0.07\,D + 0.06 \qquad (4)$$

which means that for a given diameter the pitch and therefore the threads per inch are fixed quantities, and we can eliminate them in the formula of equation 3 by substituting in that equation the value of P as given in equation 4; thus:

$$\frac{\sqrt{L}}{\sqrt{0.785 f_t}} = D - \frac{3\sqrt{3}}{4}(0.07D + 0.06)$$

and simplifying we have

$$D = 1.24\sqrt{\frac{L}{f_t}} + 0.088$$

an expression in three variables and applicable when a bolt has United States Standard threads and the pitch follows current practice.

An investigation of the above expression reveals the importance of it in the everyday work of the machine

FIG. 4. CHART SHOWING THREE VARIABLES

designer and fortunately it is possible to build up this formula into the simple chart shown in Fig. 4. As we have here only three variables the chart is very easy to read, it being only necesary to lay a straight-edge across the three scales as shown by the dash-dot line. This line then cuts out three values that satisfy the equation 5. In the example shown the three values cut out are $D = 1\frac{1}{2}''$, $L = 50{,}000$, and $f_t = 38{,}500$. This means that a $1\frac{1}{2}$-in. bolt having United States Standard threads, if subjected to a total load of 50,000 lb., would have a fiber stress of 38,000 lb. per square inch.

Similarly any one of the three variables may be solved, and the reader can build one of these charts for his own use if he follows the subjoined explanation of the theory. The equations of the scales are:

$$X = 0.0001\,L$$

$$Y = 0.0001\,f_t$$

$$Z = \frac{15(D - 0.088)^2}{(D - 0.088)^2 + 1.54}$$

where X equals the distance measured downward along the left-hand vertical line, Y the distance measured upward along the right-hand vertical line, and Z equals the distance measured along the diagonal from upper left to lower right. The values of X and Y can be obtained very easily by moving the decimal point four places to the left in each value of L or f_1. The value of Z however takes time to calculate and will be given in the table:

VALUES OF D AND Z

Values of D, Inches	Values of Z, Inches	Values of D, Inches	Values of Z, Inches
0.250	0.250	1.375	7.77
0.312	0.470	1.437	8.13
0.375	0.760	1.500	8.45
0.437	1.10	1.562	8.80
0.500	1.49	1.625	9.07
0.562	1.92	1.750	9.64
0.625	2.37	1.875	10.10
0.688	2.84	2.000	10.53
0.750	3.33	2.125	10.95
0.813	3.81	2.250	11.28
0.875	4.30	2.375	11.58
0.938	4.80	2.500	11.85
1.000	5.26	2.750	12.30
1.063	5.72	3.000	12.65
1.125	6.16	3.250	13.00
1.187	6.59	3.500	13.23
1.250	7.01	4.000	13.63
1.312	7.40		

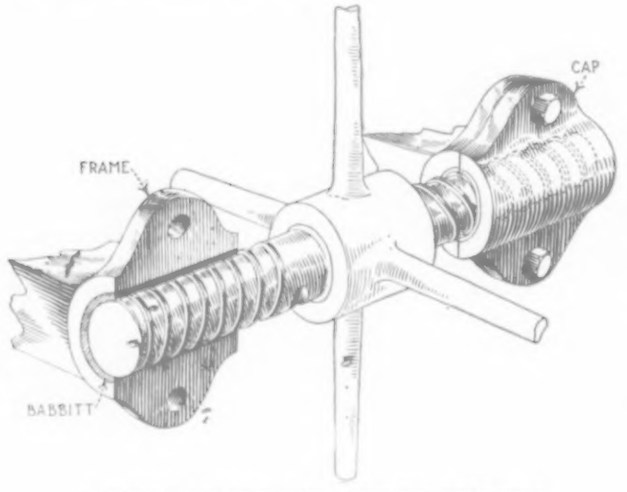
Take these values of Z as given in inches and measure them off along the diagonal and mark each point with its corresponding value of D. The diagonal in this chart must be exactly 15 in. long. Any reasonable angle may be used.

The two formulas described in this article are repeatedly used by designers and the charts shown should save much time.

A Reamer with Helical Teeth

By S. Wadsten

We make a special duplex vacuum pump with two babbitted main bearings, 1⅛ in. in diameter. A special arbor and fixture is used to insure correct alignment, and the work of scraping the bearings with hand scrapers requires from 20 to 35 min. and a certain amount of skill. The reamer shown in the sketch was designed to reduce this time.



A NOVEL REAMER FOR BABBITT BEARINGS

I tried to make the reamer from a bar of 1¼-in. tool steel with the intention of grinding it after hardening, but found that I could not harden it without cracking the spiral flutes. Next, I made one from cold-rolled steel, finishing it to size and hardening it with cyanide. This worked so well that we have reamed more than 1000 sets of bearings without sharpening and the time of finishing a pair of bearings has been reduced to five minutes.

The reamer is placed between the lower and upper half of the bearings and the latter bolted down while the reamer is being turned. Approximately 12 turns are required to finish the reaming. The bearing caps are then removed and the crankshaft assembled. I use ¾-pitch double right- and left-hand spiral ratchet form of flute; the chips can not clog, being carried out as the reamer is revolved.

The handwheel is made from a rejected pump pulley with the rim removed.

Protecting the Back Head of an Air-Hoist Cylinder

By Edward Heller

In designing an air hoist for use in our own shop I adopted the following described method of guarding against blowing the piston through the back head of the cylinder.

The piston is 8 in. long. At a distance of 9½ in. from the back head I put a ¾-in. hole through the cylinder wall, that end of the cylinder being otherwise closed. As soon as the piston passes this outlet, the air remaining in the cylinder begins to compress and by the time the piston has reached a point 1½ in. from the cylinder head, the pressure of the trapped air balances the working pressure and stops further movement.

If the piston is shot back suddenly by slippage of the load, or breaking chains, it may approach the back head closer than 1½ in. by reason of its inertia, but soon after passing this point it will have uncovered the ¾-in. opening, thus releasing the working pressure and making it impossible for the piston to reach the back head.

The hoist is operated by an ordinary three-way valve, the weight of the chain and hooks serving to return the piston when the pressure is released.

Blueprinting from Pencil Drawings

By E. R. Plaisted

In designing a special machine to suit a customer's ideas, the writer found it desirable to submit good-looking blueprints to the customer and his partners, while keeping the original drawings in pencil in order that possible alterations might be readily made. The following plan was hit upon: At first sight it might not seem any advantage over making an inked tracing from the pencil drawing, but it works out that a good portion of the original penciling can be done after the carbons are inserted, though enough of the sketch must first be filled in to avoid erasures.

After the sketch or layout has progressed thus far, carbon paper is put both above and beneath another sheet under the drawing (the lower carbon facing upward) and the sketch completed and letters and figures added.

The resulting double carbon yields almost as fine a blueprint as an inked tracing would give, and the drawing itself remains a pencil drawing. Is this a new idea, or has it already been tried out and described in *American Machinist* columns?

[We have a sample of Mr. Plaisted's carbon drawing and resulting blueprint, and can attest that the latter is quite as good as the average blueprint from an inked tracing.—Editor]

Minors Under Compensation Acts

By CHESLA C. SHERLOCK

The employment of minors is a matter of more than passing interest to employers at this time. It is not only a subject involving moral and political considerations, but one fraught with a well-defined legal liability, more or less misunderstood, but nevertheless definite and clear-cut when examined.

THE practice of employing minors doubtless arose in the earliest times under the common law, and while, by a fiction of law, they might be invested with the same rights of contract as adults, they certainly did not entertain such a relation because of the moral and political questions involved. Hence, it came about that a change in public opinion demanded that minors no longer be employed in mills, shops or workshops until they had reached certain ages, and these demands were enacted into labor laws, child labor laws, and numerous other statutes designed to prevent the employment of children except within certain prescribed limitations.

Basis of Child Labor Laws

Contrary to general opinion, these statutes did not render the employment of minors illegal generally, but merely restricted the scope of the minor's right to enter upon certain employments. It was not impossible for a minor to enter upon certain employments, but if he did enter upon employments within the prohibited class, he was deemed to be illegally employed and a certain liability fixed by statute was attached to the employer, not only for such illegal employment but also for injury or death, as the case might be.

Then, again, no matter what the age of the minor, he might be legally employed even in a prohibited employment, as a rule, if he procured due and legal consent from the proper constituted authorities.

It must be understood, in the first place, that the mere employment of a minor is not illegal. Certainly, a minor has the same right to work that an adult has, if he so desires. The illegal phase of the transaction, under the statutes, is to employ a minor in a manner prohibited by the statute. If the employer goes to the trouble to take the steps demanded by the statute, he may employ minors in his place of business and do it legally.

So long as the employer keeps within the terms of the statute, he will not be apt to find himself in conflict with the law. But employers do not always do this. Many of them do not take the trouble to look up the law they are operating under in order to know, in advance, just what they are expected to do in order to hold themselves blameless.

It is not our purpose here to examine the common law or the child labor laws extensively, but merely to point out the basis upon which they rest, in order that we may intelligently consider the liability of an employer for the employment of minors under the workmen's compensation acts.

There is a mistaken conception of the effect of the compensation acts prevailing in many quarters. Many employers honestly are of the opinion that the compensation acts will relieve them of any statutory liability for the employment of minors or others specifically treated in the labor laws. But this is not true.

The compensation acts, contrary to the general run of legislation, do not abrogate all other acts relating to master and servant or involving the industrial relation of employment. They have no effect upon the child labor laws. Where such a law is in effect, it is just as necessary for the employer to obey it today as it was necessary for him to obey it before the enactment of the workmen's compensation acts. And the fact that the employer had minors in his establishment does not say that the employer's acceptance of the terms of the compensation acts will limit his liability to these minors to the liability set out by the compensation acts themselves. The employer cannot escape his double liability in this manner, simply because the courts will not, and have not, permitted him to do so.

Rights of Minors

If the child labor laws set out certain requirements for the legal employment of minors in certain occupations it is necessary for the employer to follow these requirements strictly before the minor can be deemed to be legally employed.

And, going a step in advance, no minor who is not legally employed can be treated as an "employee" within the meaning of the workmen's compensation acts.

This may appear to some to be a very ordinary statement of liability, but suppose we examine a little farther into it and ascertain definitely what it means.

If the minor is not an employee within the meaning of the compensation acts, has he a right of recovery against the employer? He certainly has no right of recovery for the payment of compensation under the workmen's compensation acts, for he is not covered by their terms. Then, does the employer's liability end here? It certainly does not!

The minor still has his rights under the common law to sue for damages, and let me add that this right is just as much in his hands as if he were an adult employee. He has a right to a common law action for damages and is entitled to recover all that the whim of a jury will allow him. Not only that, but the chances are that the child labor law will contain a nice penalty against the employer for his illegal employment.

In the case of minors, the recovery is nearly always higher than it is in the case of adults for the same injury. This is due to the fact that the natural sympathy of the jury is stronger for a maimed or deceased minor than it is for an adult in identical circumstances. The recovery, when made, under the common law is generally greatly in excess of the recovery allowed under the terms of the compensation acts. As a rule employers pay dearly for their inattention in regard to the legal employment of minors.

The cases arising are, naturally, those arising where the employment of the minor has been illegal. The point concerning employers, when their minor employees have been injured, is whether or not they are entitled to compensation under the acts.

We have made a very extended examination into this

subject, because it is a matter which has caused more than the usual amount of controversy and speculation among the courts. It is only within the last year that judicial opinion has finally crystallized sufficiently to formulate a rule which is more or less definite on the subject.

Ever since the adoption of the compensation system employers as well as those who administer the compensation acts have been more or less "on the fence."

An Illinois Case

An Illinois case, which is generally regarded as one of the leading cases upon the subject, will serve to illustrate the way the courts look at this question. In this case it was shown that the defendant employer was engaged in the manufacture of sewing machines, and in the prosecution of such business, was operating sand-papering machines, with rollers and gears; that the plaintiff was 15 years of age, and contrary to the statute, was employed by the defendant to work at and about such a machine; and that, while so working the plaintiff's hand was caught between the rollers of said machine and injured to such an extent that he claimed $10,000 damages. Judgment was allowed him in the sum of $3000, from which decision the employer promptly appealed to the appellate court on the ground that the lower court was without jurisdiction as the case was one arising under the Workmen's Compensation Act and that the plaintiff's sole remedy was thereunder. The appellate court adopted the view of the employer, so that the plaintiff appealed his case to the supreme court which said:

> The question to be determined is whether or not the parties were operating under the Workmen's Compensation Act. If they were, then the superior court did not have jurisdiction. It is admitted that the defendant was operating under the act. The plaintiff was a minor 15 years of age and was not elected to be bound by the act.

The Child Labor Act of Illinois provides that "no child under 16 years of age shall be employed at certain kinds of work, among which is operating or assisting in operating sand-papering machinery." The court ruled on this point that:

> Plaintiff was between the ages of 14 and 16 years, and might legally be employed in a manufacturing establishment though not to work with certain appliances and machinery, including sand-papering machines; but he could not be legally employed without a permit, required by law by minors between the ages of 14 and 16 years. No such permit was obtained by plaintiff authorizing his employment in the defendant's factory for any purpose, and, as we understand the definition of employees made subject to the Workmen's Compensation Act, it embraces only minors who are legally permitted to work. A minor under age of 14 could not be lawfully employed to work in a manufacturing establishment, and if employed contrary to law, and injured while so employed, he could not be regarded as an employee within the provisions of the Workmen's Compensation Act. The same rule applies where a minor between the ages of 14 and 16 years is working without a permit having been obtained. In both cases, the employment is unlawful.
>
> In this case the plea did not aver that any permit had been obtained authorizing the plaintiff's employment for any purpose, and as we understand the record the proof shows no such permit was obtained. Without such permit he was no more legally permitted to work in defendant's factory than would be a minor under 14 years of age. In the one case, a minor is not legally permitted to work at all, while in the other he is only legally permitted to work upon obtaining the permit required by the Child Labor Law. If the plaintiff was not legally permitted to work, he is not embraced within the provisions of the Workmen's Compensation Act, and his action to recover damages (under the common law) was properly brought. . . . Judgment of the appellate court is reversed, and judgment of the superior court is affirmed.

Other Decisions

In New Jersey, it has been held that the Compensation Act applies to minors unless notice to the contrary be given by or to the parent or guardian of the minor. It has been held that the provision is not unconstitutional, as depriving minors of the equal protection of the law. In a New Jersey case, it was held that a notice that an employer elects not to come under the provisions of the Compensation Act is not sufficient, where it is posted in the works or given to the minor workman in his pay envelope. But, in another case, it was held that where the parent or guardian of the minor actually sees the posted notice or the notice in the pay envelope, then the legal requirements as to notice are fulfilled, and an action at common law may be maintained for injuries to the minor. The reason back of this decision is that the law ordinarily assumes that minors are incapable of contracting, even on their own behalf, except for necessities, all other contracts they enter into being voidable at their own option. In order for employers to protect themselves in this matter by binding the minor it will be necessary for them to communicate with the parent or guardian of the minor.

The Wisconsin Act, however, expressly provides with the election of the employees to be bound by the terms of the Compensation Act, that minors shall be considered the same and shall have the same power of contracting as adult employees. And it has been held in that state that a minor who neither gives to the employer nor files with the Industrial Commission any notice, electing not to be subject to the provisions of the Compensation Act, is within its provisions, and cannot maintain an action for damages under the common law.

It has also been held in Wisconsin that a minor need not be represented in compensation proceedings by a guardian, the court saying:

> It is quite significant that minors, mentioned for the purposes indicated, are not only empowered to contract to the same extent as adults, but are, for all such purposes, to be considered the same as adults. This is a pretty plain legislative declaration that a guardian to represent a minor, in matters within the jurisdiction of the Industrial Commission under the Workmen's Compensation Act, is not essential.

The Minnesota Act

The Minnesota Act, likewise excludes minors whose employment is prohibited by law, and they are entitled to relief under the common law.

In a Minnesota case, decided in 1917, after stating that the statute, "minors who are legally permitted to work under the laws of the state," was intended to exclude from the act minors whose employment is prohibited by law, the court said:

> In the absence of legislation to the contrary, all minors may lawfully engage in such employments and work as their age and capacity fit them, and in this respect are "legally permitted" to work, though their contracts, except as to necessities, are voidable at their election. In fact, we have no statute expressly permitting the employment of minors, and the use of the words "legally permitted to work" was not intended as a reference to permissive legislation. But we have statutes, and have had

for many years, known as the Child Labor Laws, by which the employment of minors of certain age is expressly prohibited, in specific classes of employment deemed detrimental to their moral welfare and dangerous to their life and limb. And, in making use of the language quoted, it is apparent that the legislature intended to preserve the status of minors, in respect to their employment in dangerous occupations, and to remove them from the compensation act, when employed in violation of law. No other construction of the statute can be adopted that would not be in discord with our whole legislative policy upon the subject.

Furthermore, in Massachusetts, it was held that the fact that a minor has recovered full compensation does not affect the right of a parent to recover for his loss because of the child's injury; and it was also held that the provision that the insurer shall pay a part of the medical expense made necessary by an injury to an employee does not take away, by implication, the parent's remedy for his own loss in the shape of an injury to the minor, although the parent could not recover the expenses which he had been compelled to pay, but which had been paid by the insurers.

Employers may naturally protest that this is an error of law to permit two recoveries to be made for the same injury. While it may appear to be a double recovery, such is not the case. The rule is that no person can make two recoveries for the same injury. If a person is injured under such circumstances that he has a right to compensation as well as a right of action under the common law, he must elect as to which method he will pursue and he must accept the results of such pursuit, as he cannot recover himself under both cases. But in the instance mentioned above, the law gives two separate and distinct causes of action in the case of the injury of minors. The parent or guardian has had from time immemorial a right of action for damages for the loss of services occasioned by the injury of the minor. Under the peculiar phase of the Compensation Act, the minor is treated the same as an adult, so he has a right to compensation himself, provided he has been legally employed.

The conclusions to be drawn from these cases regarding the employment of minors are of vast importance to employers, especially where such minors are employed in manufacturing enterprises, where they are apt to come in contact with child labor laws and other legislation limiting or prohibiting their free and unrestricted employment.

So, if a minor is illegally employed, he stands in the same relation to the employer that he did at common law prior to the enactment of the compensation act; he has his right of action for damages, by next of friend or guardian, and is entitled to recover damages to the extent of his injuries, to be ascertained by the jury.

But, unfortunately, the employer does not stand in the same relation that he did under the common law. The workmen's compensation acts have literally bound him hand and foot so that he cannot defend himself in a common law action, even though the injured minor was never within the provisions of the compensation act, because the compensation act deprives the employer of his common law defenses *whether he operates under the compensation act or not.*

These defenses, which include the doctrine of assumption of risk, the fellow-servant rule and the rule of contributary negligence were the employer's most effective defensive weapons under the common law. They limited the employer's liability for damages only to those cases where he had been guilty of actionable negligence, and reduced his percentage of losses fully 90 per cent.

But, now, all this is swept aside and it simply means that where an employer, who employs a minor illegally, is confronted with the injured minor in court that the minor can recover damages practically without fail and to whatever extent the jury cares to allow.

It means that employers must take care to employ minors only in the way sanctioned by the statute and they must do all within their power to make the employment of minors legal so that they will come under the compensation act and the basis of liability will be definitely and accurately fixed. Where permits are all that is necessary, obtain them by all means, as it will mean money in the pocket of any employer to do so.

Pipe Dreams of a Tramp Machinist—The Budding of Genius

By Glen Quharity

Johnnie was one of the most inventive little cubs that ever grew up in a machine shop. He would much rather spend a day in inventing ways to do something that nobody wanted done than to devote an hour or so to doing something useful. This does not mean that Johnnie was lazy or sought to shirk his share of whatever was doing. He was a bright, active lad, with an aptitude for mechanics and an investigating turn of mind that just naturally *had* to know why things were as they were instead of being as they ought to be.

He was the original guy who invented a way to make the planing machine cut both coming and going instead of wasting half its time rattling back to the starting point, and he was also the lad who made a

hacksaw blade with each alternate tooth pointing the other way so that the efficiency of the machine would be doubled.

Johnnie hated to see things going to waste. He wanted Bill Shailer, the engineer, to connect the exhaust from the main engine to the pumps and fan engines that labored incessantly night and day to keep steam and air moving in the dry houses, and he seriously considered the feasibility of putting a centrifugal pump in the wheel pits to pump the water back into the head race when the pond was low.

Johnnie, however, was no fool. He was merely learning the business in the only way that it can be properly learned; by butting his head against the laws of nature and finding out for himself how real they are. To be sure, he never got the pump in the tail race—that was too big a job—and he never convinced Bill that exhaust steam was a good thing to run a fan engine with, but in the latter case he must have been on the track of the right idea; else why is a compound engine? I think he privately tried out the waterwheel-and-pump scheme in the little brook that ran through his back yard, but it probably didn't work well for he never told us about it.

I believe I have told you of the old blacksmith shop belonging to the Brookdell company. It was a museum of mechanical absurdities and things not so absurd that had been sidetracked at various times since the beginning of things, and it was Johnnie's delight to monkey around there, "makin' som'p'n," as he would express it.

Out of a cheese-box, a pulley which was minus a rim and a few other odds and ends, he constructed a very creditable blower that was, beyond a doubt, the immediate cause of the efficient Sturtevant fan being installed to blow the blacksmith shop fires. A shaft, made of discarded steam pipe and supported by wooden bearings fastened to a timber running between the stock shed and the machine shop, which permitted the

installing of a power hacksaw at the nearest point to the raw material supply, was his idea. He also demonstrated with a bicycle pump that sheet-metal shells could be blown off the punch in the big re-draw press, with the result that within a few months an up-to-date compressed-air unit was installed in the factory and air ejectors, air hoists, air conveyors for light material, etc., became common.

All this was a good many years ago. Johnnie now rides around in a gas buggy and is superintendent of a bigger plant than the Brookdell company.

One of the relics that had been preserved from the early days was the post drill press that had served the old man in the little old shop by the pond. This kind of a machine was designed to bolt onto a post, and was run by man power through the medium of a crank and a pair of bevel gears. A small but heavy-rimmed balance wheel on the vertical spindle of the machine helped the operator over the hard spots and the feed was supplied through a nut and handwheel ordinarily operated by a ratchet and pawl.

Standing in one corner, and covered with the rust and dirt of ages, was another relic—the governor from a remote predecessor of the shining, business-like, 200-hp. Wheelock engine that was now running the factory. It was a tall ungainly thing, with "fly-balls" that would make very creditable shot for a trench mortar in a modern war, but Johnnie couldn't bear to see it standing there in the corner just going to waste.

After a week of feverish activity with much running back and forth between the machine and blacksmith shops, Johnnie invited us out to the blacksmith shop.

He had taken off the balance wheel of the drill press and in its place attached the old governor. The feed nut and screw had also disappeared and the sleeve connected to the valve-regulating mechanism of the governor by a complicated system of levers. When you turned the crank you fed down the drill and the faster you turned the harder you fed.

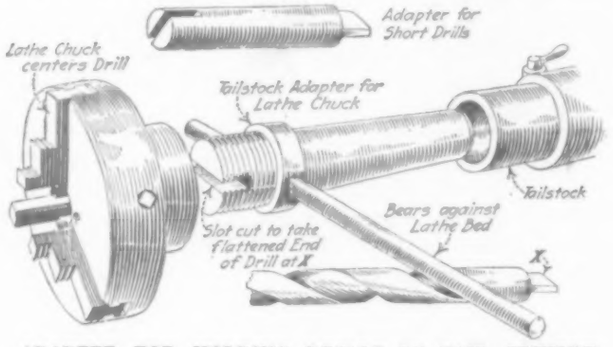
This scheme would not have worked very well on larger sizes, but the limit in this case was a half-inch drill, and if you wanted to increase the feed pressure, go to it; you couldn't burn the drill.

Of course, anybody could drill a hole much quicker and easier on the big drill press in the machine shop, or for that matter could have done the same on the converted machine before Johnnie improved it, but nobody mentioned that to Johnnie; he found that out himself at a later period. Meanwhile, he was happy. He had "made som'p'n."

"Positive Drive" Drills Adapted to Lathe Tailstock

By H. H. Parker

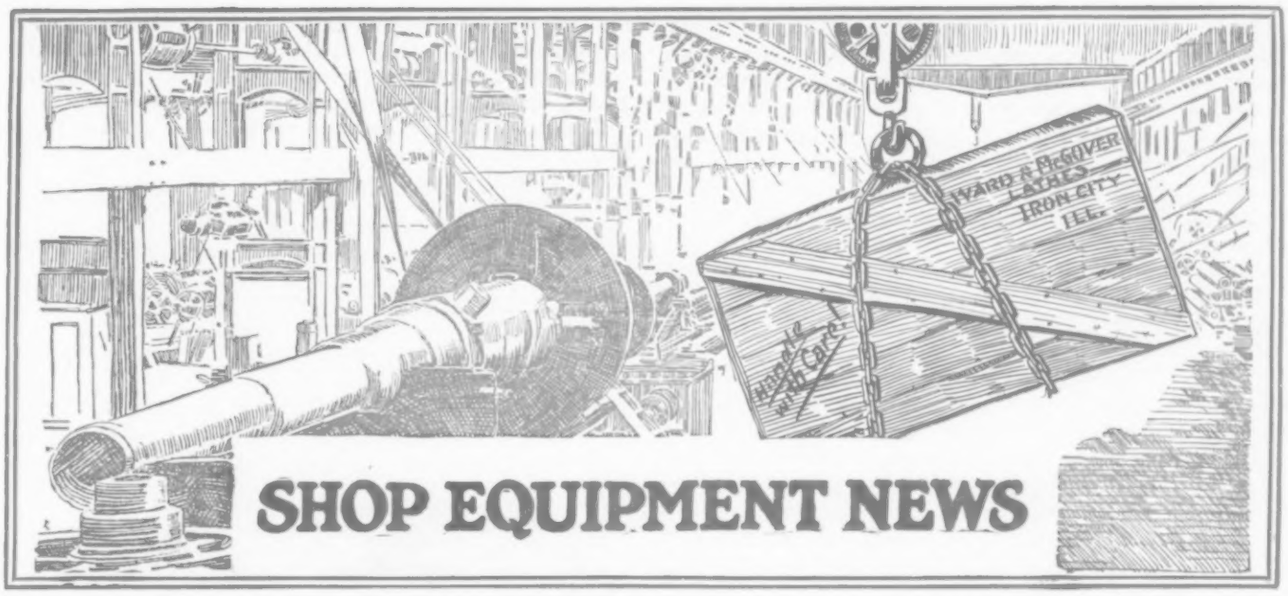
A small drilling machine had been fitted with a Pratt drill chuck and all the drills and counterbores had had their ends flattened for positive driving in this chuck. As these drills were frequently used in the lathe, an adapter was made to fit the tailstock and take the small


Adapter for Short Drills
Lathe Chuck centers Drill
Tailstock Adapter for Lathe Chuck
Tailstock
Bears against Lathe Bed
Slot cut to take flattened End of Drill at X
X

ADAPTER FOR HOLDING DRILLS IN TAIL SPINDLE

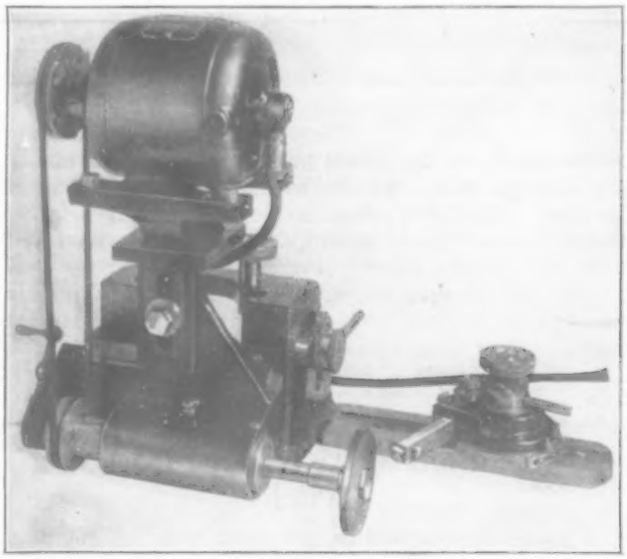
universal chuck used on the lathe. A slot was cut in the threaded end of the adapter, as shown in the sketch, to take the flattened drill ends, while the drills were held and centered by the chuck, thus making a positive holding arrangement. A piece of drill rod driven through a hole in the adapter body and resting against the lathe bed prevented the combination from turning.

In case the drill shanks are too short to reach the slot, an extension piece with a tongue at one end and a slot at the other may be used, and if the tongue and slot are at right angles this will help the chuck center up the drills.



Lafayette Portable Universal Grinding Machine

This useful little machine, manufactured by the Lafayette Tool and Equipment Co., Lafayette, Ind., is adaptable to a wide range of light work, and is particularly recommended by the makers for threaded work —internal or external. It is said to grind to within 0.0001 in. all types of gages, taps and dies, reamers and cutters, wristpins, pistons, etc. It can be used as a bench machine or in conjunction with a lathe or other



LAFAYETTE PORTABLE UNIVERSAL GRINDING MACHINE

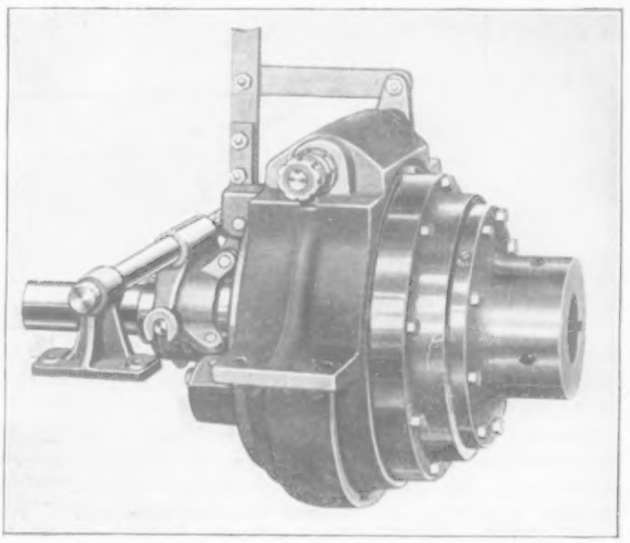
machine tools. It is capable of grinding holes as small as $\frac{3}{8}$ in. in diameter by 8 in. in length and is convenient for grinding milling cutters while in position. Button dies may be ground, teeth and flutes, at one setting. It is possible to obtain any angle desired as the machine is adjustable horizontally $3\frac{1}{2}$ in., vertically $2\frac{1}{2}$ in., and angularly to 20 deg., these adjustments being regulated by micrometer readings graduated to 0.001 in.

As to structural features, the machine is built on the unit basis to insure interchangeability of parts. The spindle is hardened and ground, supported in Non-Gran bronze bearings, and runs in a reservoir of oil. The bearings are tapered and readily adjustable to compensate for radial wear or end play. A micrometer-graduated wheel-truing arrangement provides means to form the wheel to any desired shape; the wheel truing arm will accommodate three diamonds for facing and shaping the wheel. A General Electric universal motor is furnished that may be connected to any lamp socket and the drive being independent of the main shaft avoids any pull from the belt. A $\frac{7}{16}$-in. endless belt is used, adjustment being provided to take up the slack. The machine is furnished complete with all necessary attachments including a set of six grinding wheels.

Snow & Petrelli Reversing Gear

The reversing gear shown is known as the "Husky Joe" type, and is manufactured by the Snow & Petrelli Manufacturing Co., New Haven, Conn. While intended primarily for marine work, it may prove useful for special purposes in the machine industry.

The gear is built in four sizes, with capacities ranging from 9 to 52 hp., according to size. The design



SNOW & PETRELLI REVERSING GEAR

employs the internal gear principle, using the three-point contact system, but eliminating the central spur gear; thus obtaining large intermediate gears and bearings, and consequent strength and smoothness of action. The device has a balanced design; the four pinions for the drive and the four for the reverse are placed symmetrically from the center.

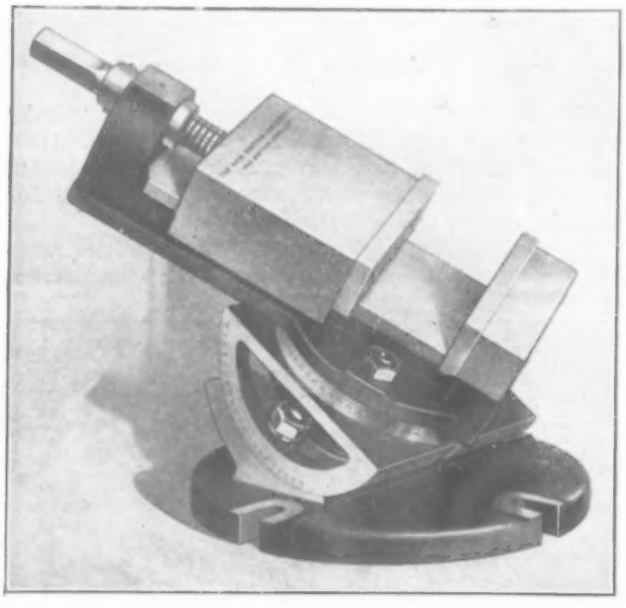
Provision for lubrication is a distinctive feature, in that when oil is admitted to the periphery of the gear it flows through a channel directly into all of the hollow pinion studs, which act as oil reservoirs and afford ample lubrication to the bearings and all parts of the gear.

The ratio of reverse speed amounts to about 85 per cent. of the motor speed, and when the gear is in neutral position there is no effect due to centrifugal force upon the clamping toggles or fingers. The brake band is free to grip evenly through its entire circumference and is supported by a bracket which surrounds the brake and, being suspended, does not drag on the drum when not in use. The gear is designed for shafts with diameters from 2½ to 5 in., and the weights of the four sizes are 190, 566, 950 and 1900 lb., respectively.

The New Britain Universal Vise

There has recently been placed on the market a tilting and swivelling vise for use in milling and drilling machines, and in laying out work, that is unique in that it combines in one tool the means of obtaining any desired angle.

As will be seen from the illustration the vise has a large round sub-base provided with slots for holding-down bolts, the upper surface being machined to receive



UNIVERSAL VISE

the tilting member which is held to it by two bolts extending through slots to a recess in each end of the member.

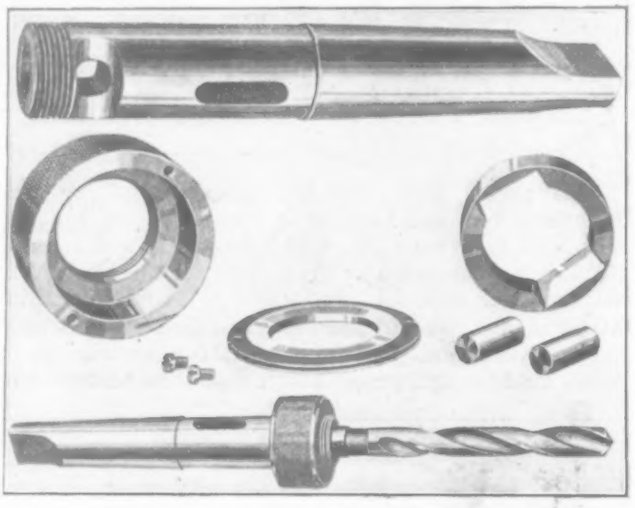
This part is graduated and may be tilted to any angle from vertical to 10 deg. below the horizontal. A circular boss cast upon the upper surface of the tilting member is also graduated and receives the base of the vise which may be turned to any desired position. Thus, any angle within the complete circle may be obtained in the horizontal plane, and this movement combined with available angles in the vertical plane enables the user to set his work in any position without recourse to tilting plates, angle plates, or straps and bolts.

The jaws of the vise are removable and are hardened and ground. They are 1½ by 5¼ in. in size, and the complete tool weighs 55 pounds.

It is made by the New Britain Tool and Manufacturing Co., New Britain, Connecticut.

Roberts Improved Drill Holder

This drill holder hardly needs explanation as it is designed to serve an obvious purpose, as can be seen from the illustration; also its construction is apparent. The need of this useful tool is evidenced by the fact that in the average assortment of shop drills will be found many with twisted or mutilated tangs. With this holder the drive takes place at the large end of the



ROBERTS IMPROVED DRILL HOLDER

shank which is the logical point to receive the strain. To lock the drill in place, the knurled collar is turned by hand. The loose collar, inside, is thus forced up by the screw and acts as a cam, forcing the two hardened rolls into recesses ground in the drill, holding it securely gripped and preventing it from twisting or dropping out and incidentally preventing injury to the drill or holder. This holder is manufactured by the Roberts Manufacturing Co., 152-6 Brewery St., New Haven, Connecticut.

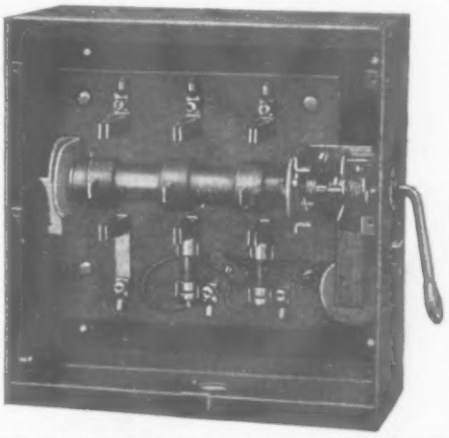
Westinghouse Safety Motor-Starting Switch

A motor-starting switch, known as type WK-100, that provides protection to both the operator and the motor, has just been placed on the market by the Westinghouse Electric and Manufacturing Co. It is designed for connecting single or polyphase alternating-current motors of from 1 to 20 hp., 250 and 550 volts, directly to the line without the use of auto-transformers or resistance.

All of the mechanism with the exception of the operating handle is inclosed in a steel box. The protective devices are easily accessible on opening a door in the cover, but this door can not be opened except when the switch is in the "off" position (nor can the switch be closed when the door is open) and all parts reachable

are then dead. Therefore, it is impossible to receive injury from contact with live parts when either operating the switch or making ordinary adjustments.

No-voltage protection to the motor is provided by a magnetic release which opens the switch automatically on a failure of voltage. Overload protection is provided by means of relays resembling cartridge fuses



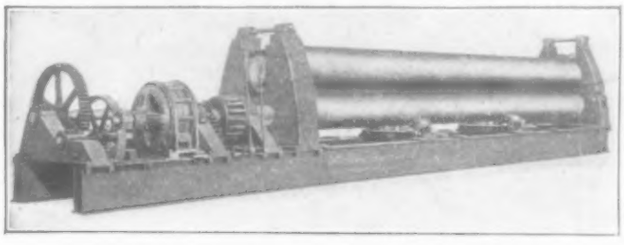
SAFETY MOTOR STARTING SWITCH, TYPE WK-100

in appearance, each of which contains a contact connected in series with the release magnet. Harmless momentary overloads have no effect on the relays, but as soon as the load on the motor becomes dangerous, the relay contacts open the magnet circuit and the switch automatically flies open. The relays then automatically reset themselves. The switch is so arranged that it can not be kept closed on an overload or no-voltage, even if the handle is held in the "on" position.

Wickes Heavy-Duty Bending Rolls

Wickes Bros., Saginaw, Mich., have recently completed for a special order a large set of bending rolls as shown in the illustration.

The bed is built of 24-in. I-beams and the housings are semi-steel castings. The housing at the right is



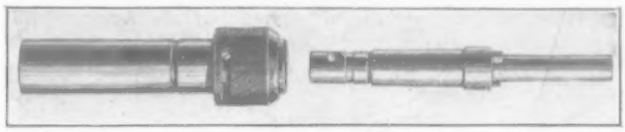
WICKES HEAVY-DUTY BENDING ROLLS

Specifications: Distance between housings, 32 ft. 2 in.; capacity, 1-in. plate; diameter of top roll, 30 in.; diameter of bottom rolls, 20 in.; motor, 150 hp.; weight, 270,000 lb.

hinged so that it can be opened to permit the removal of tightly rolled plates. Power is furnished by a 150-hp. motor mounted on the bed. All driving gears are steel.

S. & C. Easy-Lock Holders for Reamers and Cutters

This quick-acting holder for reamers and cutters is designed to hold such tools securely or release them quickly through hand manipulation only, and without the use of hammers, wrenches or other mechanical means. It is manufactured by the S. & C. Manufacturing Co., Detroit, Mich., and has a variety of uses, such as holding interchangeable counterbores, tapered bridge reamers or floating shell reamers. In the latter case, however, a separate shank is of course required in connection with the easy-lock holder. The holder is made in four sizes to accommodate ten different sizes of shanks which will handle the entire line of standard shell reamers. The shell counterbores furnished with

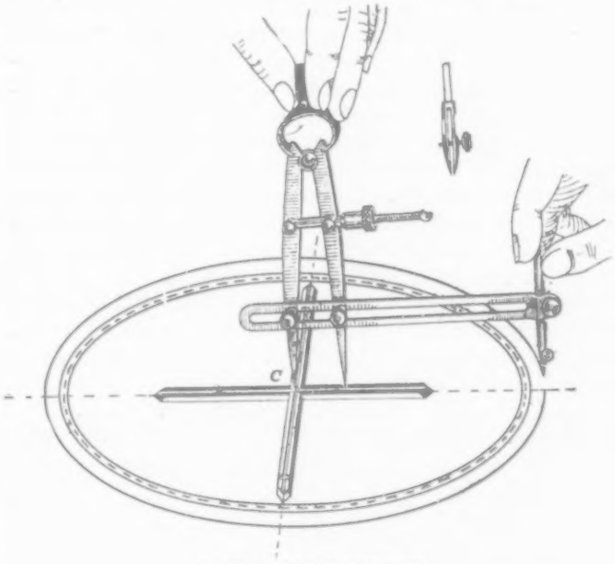


F. & C. EASY-LOCK HOLDERS AND SHELL-REAMER SHANK

this holder are arranged for a two-point drive and can be held rigidly, or in a floating position so that the pilot can follow the hole without a tendency to cramp. This type has an advantage over solid counterbores in that it may be ground until only one-third of the original length remains. The holders can be furnished with either taper or straight shanks suitable for screw-machine work.

Reid's Ellipsograph

Daniel C. Reid, 2717 North Crosky St., Philadelphia, Penn., placed on the market the ellipsograph as illustrated herewith. The instrument is provided with pen and pencil parts and by detaching the slotted bar it

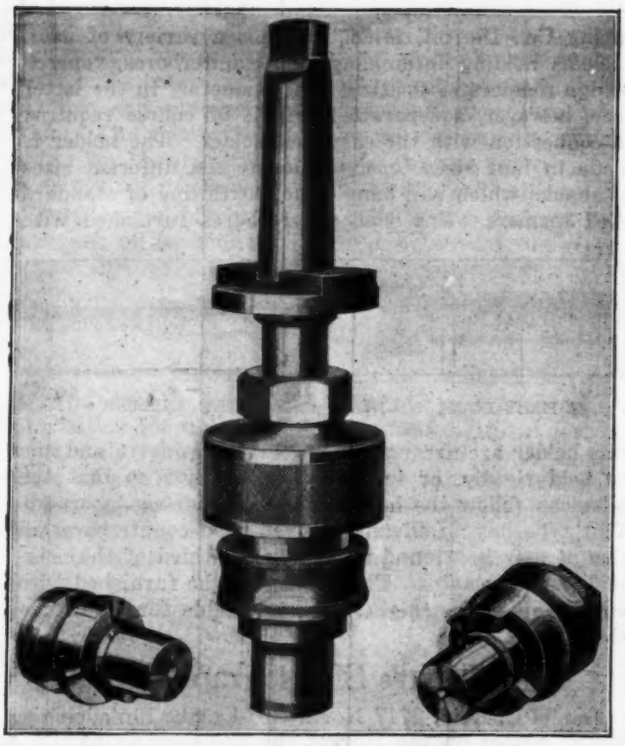


REID'S ELLIPSOGRAPH

can be used as an ordinary spring divider. It is claimed that by its use all kinds of ellipses with major axes of from 1½ to 12 in. can be drawn in one operation; also that it can be used for drawing circles up to 12 in. in diameter.

Roberts Improved Friction Chuck

A friction chuck, simply designed and positive in operation, is manufactured by the Roberts Manufacturing Co., 152-6 Brewery St., New Haven, Conn. The chuck is well made, having no feathers or setscrews to work loose and but few working parts. It can be properly adjusted for a tap in short order, and, once adjusted, can be depended upon to remain so and to slip when the tap bottoms, thus preventing the breaking of

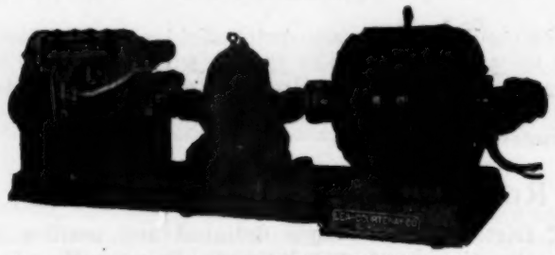


ROBERTS IMPROVED FRICTION CHUCK

taps. The socket for studs and taps is provided with interchangeable nuts for different sizes and the sliding collar, when lifted, permits the socket to be removed or changed while the machine is running—a very desirable feature for saving time. The driver for the sockets relieves the working parts of the chuck from all strains as it is arranged to fit into the recess of the drill-spindle nose, thus preventing the tang from twisting or breaking. The cup is designed to retain oil and furnish ample lubrication for all wearing parts. With each chuck is furnished a spanner wrench and three standard taper drill sockets, Nos. 1, 2 and 3; also one tap socket and one stud socket, for setting studs. Interchangeable nuts, ranging in size from ⅜ to 1¼ in. for No. 1 chuck to 1¼ to 2½ in. for No. 2 chuck, can be furnished as desired.

Lea-Courtney Gas- or Electric-Driven Fire Pump

It is always desirable to have two independent sources of power for a fire pump so as to lessen the chances of its being put out of commision when a fire occurs. In some states, a double drive is required by the Underwriter's regulations.

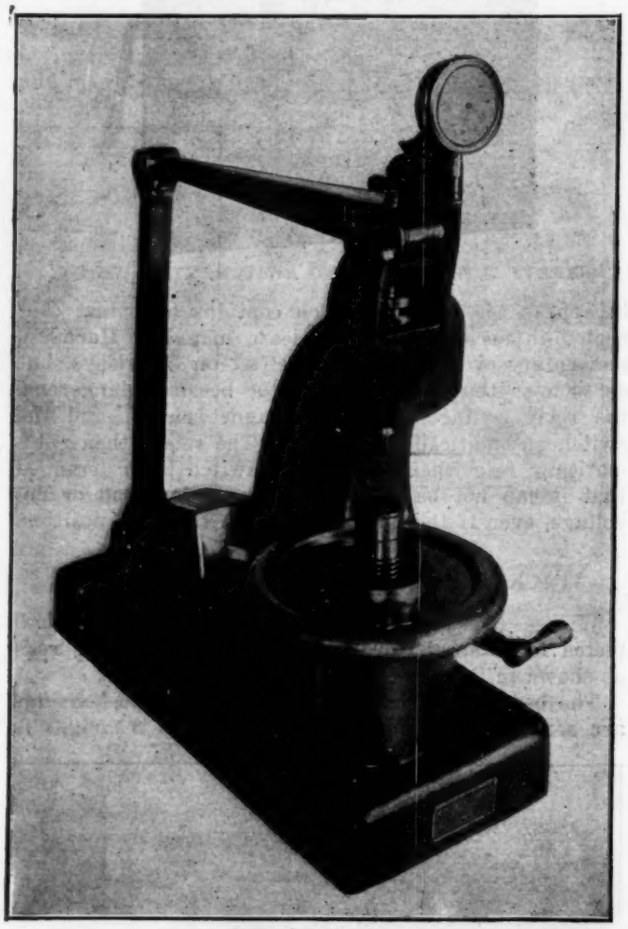


GAS- OR ELECTRIC-DRIVEN FIRE PUMP

The usual form of drive is a steam engine and electric motor, though where there are two separate sources of current two electric motors are frequently used. Sometimes neither steam nor a second source of current is available, and in that case a pump such as that shown in the illustration may be used. This pump is of 1500 gal. per minute capacity and is driven by a Westinghouse 150-hp., alternating-current motor and a 140-hp. gasoline engine. It is built by the Lea-Courtney Co., Newark, N. J.

Rockwell Hardness-Testing Machine

S. P. Rockwell, 122 Dickerson St., Syracuse, N. Y., has placed on the market a direct-reading hardness testing machine as shown in the illustration. By the shifting of a weight, the test pressure can be varied to suit conditions. Application and release of the weight are controlled by a hand-operated lever at the right of the machine. The work-holding bed is arranged so that chucks designed to hold particular classes of work can be used. The testing points are made of a special alloy and it is claimed they can be used for 2000 tests before relapping.



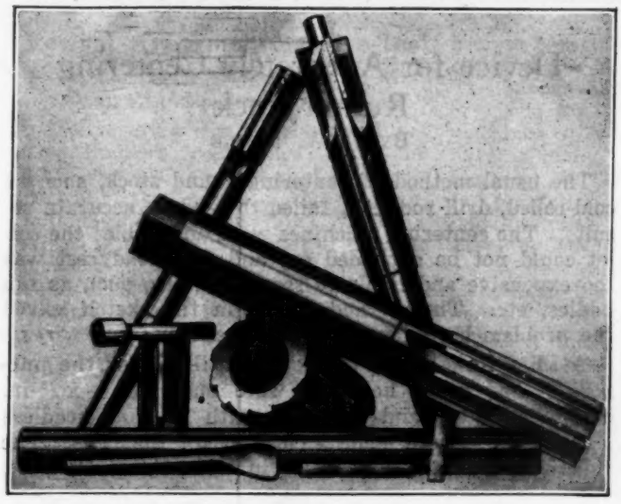
ROCKWELL HARDNESS-TESTING MACHINE

Specifications: Maximum opening, chuck to testing point, 2 in.; depth, testing point to frame, 2½ in.; minimum rounds possible to test, 1-16 in.; minimum thickness of steel possible to test, 0.03 in.; height, 18 in.; length, 15 in.; width, 7 in.; approximate weight, 52½ lb.

Economy Reamers and Counterbores

High-speed blades of tapered section staked into bodies of tough but low-cost material is the principal claim for economy advanced by the H. H. Arnold Co., Rockland, Mass., for its new line of reamers. The reamers were developed with the idea of producing tools requiring a minimum amount of high-price material and labor in

their make-up and a consequent reduction in first cost. Another claim for economy is the adjustable feature, made by tapering the slots, so that driving the blade outward increases the diameter and maintains the cutting point at the end. This adjustment is to compensate for wear only, it not being practicable to adjust for oversize holes and then back to standard size. Such a procedure would go beyond the scope of the reamer



ECONOMY REAMERS AND COUNTERBORES

which is intended for accurate work on a production basis. As to the blades remaining set after adjustment, it is said that the area of holding contact is so great that there is no tendency for them to move.

Economy counterbores have no means of adjustment as they are built up from high-speed-steel blades brazed into bodies of machinery steel. The pilots are interchangeable, ground to size and held in position by a setscrew. Three standard shanks cover the range of counterbores that are stocked in all standard sizes, from $\frac{3}{4}$ to $2\frac{5}{8}$ in. outside diameter.

Champion Safety Lathe Dog

The safety feature of the lathe dog made by the Western Tool and Manufacturing Co., Springfield, Ohio, will be appreciated at a glance. Projecting setscrews, always an element of danger, are eliminated by the

CHAMPION SAFETY LATHE DOG AND WRENCH

recess into which the head fits. The dog is thus made safe and neat in appearance, while at the same time retains the square-head setscrew. The extra metal inclosing the head also serves to balance the dog. A socket wrench is provided, making it as easy to use and as positive as the old-style dog. It is made in all standard sizes from electric furnace steel and can be furnished with straight tails as well as bent tails and with single or double setscrews for either shape.

Champion Turning Toolholder

The Western Tool and Manufacturing Co., Springfield, Ohio, has added to its line a drop-forged toolholder which has a wedge and cam lock for holding the cutters. With this arrangement the cutter is gripped

CHAMPION TURNING TOOLHOLDER

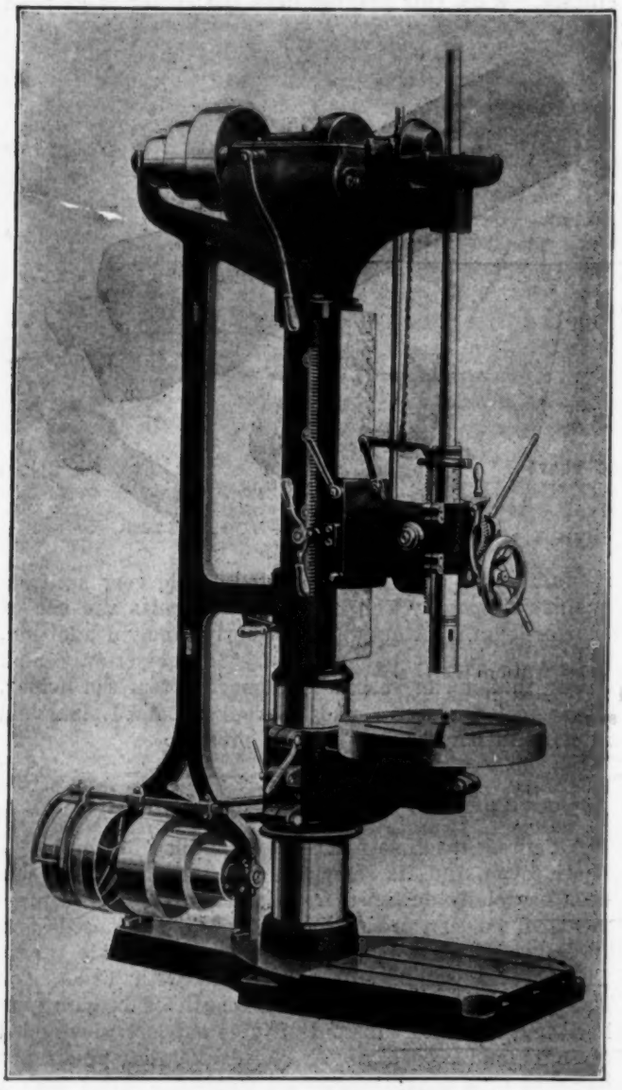
its full length and as a consequence held very securely against slippage. The holder also permits the use of shorter-length cutters than formerly, and, in addition, the cutter cannot be marred by the setscrew, which means that it can be readily removed from the holder. These toolholders are made in four standard sizes and in straight lengths only for the present.

Sibley 24-In. Drilling Machine

A drilling machine made by the Sibley Machine Co., South Bend, Ind., is shown in the illustration. It has been especially designed to meet the exacting requirements of modern production methods. The speeds and feeds are selective and have an unusually wide range. The base is well ribbed and braced with T-slots for clamping work. The increased length of bearings on head and arm and substantial table support give added strength and accuracy. The head and the spindle are balanced by a weight supported inside of column with a Diamond chain running over large-diameter sheaves. The safety of the operator is assured through the inclosing of gears and the belt guards can be furnished as extra equipment.

One of the later improvements is the fitting of all drive-shaft bearings with die-cast split bushings of a high-quality anti-friction metal. These bushings are interchangeable and insure long life to the bearings and easy replacements. Drive pulleys and three-step cones with wide belts, and the generous bevel and back-gear ratios deliver ample power to the spindle. The long range of the head and spindle on the column permit the use of large jigs. Back gears of the sliding type are fully inclosed and operated by a single lever and the spindle is provided with ball thrust bearings.

Another feature of this machine is the geared feed having four changes and a neutral position. Feed changes are obtained by moving a knob conveniently located in the center of the handwheel, four feeds being provided for each spindle speed. The initial drive of the feed shaft is from the top cone shaft through spur gears and two-to-one spirals, the latter bronze and steel respectively. This arrangement is very compact; the gears run in an oil bath and are completely inclosed. The worm gearing also runs in an oil pocket. The adjustable automatic stop is quick and positive in action.



SIBLEY 24-IN. DRILLING MACHINE

Specifications: Height to top of cone pulley, 94 in.; height with spindle up, 124 in.; maximum distance, spindle to base, 52½ in.; maximum distance, spindle to table, 25½ in.; traverse of table on column, 13 in.; traverse of head on column, 25 in.; diameter of table, 21½ in.; diameter of column 8 in.; diameter of spindle, smallest, 1⅝ in.; diameter of sleeve, 3 in.; feed of spindle, 10½ in.; Morse taper hole in spindle, No. 4; spindle speeds, r.p.m., 29, 88, 116, 126, 250, 495; diameter steps on cones, 5½ and 11⅞; width of belt on cones, 3½ in.; tight and loose pulleys, 12 x 3½ in.; driving shaft, r.p.m., 500; horsepower, maximum, 3; working surface of baseplate, 21½ x 20½ in.; floor space required, 23 x 63 in.; weight (net), 1900 lb.; weight (crated), 1975 lb.; weight (boxed for export), 2300 lb.; cubic contents of box, 83 cu.ft.

Hand feed and quick return of spindle is through the medium of a three-lever spider at the right of the feed box. The handwheel is of large diameter.

Special attention has been given to the oiling of the machine. All bearings are equipped with oil cups, grooves and channels. The loose pulley is self-oiling and is said to run several months without attention. All feed gears are completely inclosed and run in oil.

The spindle sleeve and all the shafts are ground and all machines are thoroughly tested before shipment.

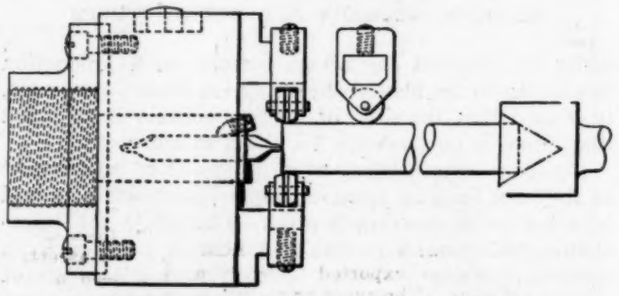
A positive geared tapping attachment, geared or belted motor drive, round or square tables with T-slots and oil pocket, oil pump outfit complete and quarter-turn countershaft can be furnished as extra equipment.

Device for Accurately Centering Round Stock

By F. W. Runge

The usual method of centering round stock, such as cold-rolled, drill rod, etc., failed to produce accurate results. The centering machines were unreliable; the collet could not be depended on, and the steadyrest was too expensive and liable to scar the work, such as tap bodies, etc. The method shown in the sketch solved the problem both for speed and accuracy.

A solid three-jawed chuck was utilized for the purpose. The roller housings were made of ½ x ¾-in. cold-rolled steel and attached with a ¼-in. headless screw. They were made a close fit for the jaws. The rollers are ½ in. in diameter, $\frac{5}{16}$ in. wide, and $\frac{5}{32}$-in. bore,



CENTERING DEVICE FOR ROUND STOCK

with a 5-deg. bevel both ways, as shown in the sketch, leaving a $\frac{1}{16}$-in. flat at the center. The rollers are ground true after hardening. The pins and rollers should be glass hard to resist wear.

When setting up, the rollers must not be pressed too hard against the work. The point of the center drill is just a trifle back of the center of the rollers.

The drill holder is turned a close fit to the bore of the chuck and fitted to a collet or adapter in the spindle. It is also bored to the right depth to act as a stop for a double-end center drill. To facilitate the removal of the drill, the binding screw was placed at the end, the angle shown being sufficient to hold the drill in place.

It is obvious that with the work held in the hand and the rollers rotating with the chuck, a perfect job is the result. The tailstock is fed up in the usual manner. It required but 40 sec. to center both ends. The work can be withdrawn with the lathe in motion but the latter must be stopped before starting a new piece. A bell-mouth center in the tail spindle is best when the stock is cut off squarely.

A bench lathe is best for work 1½ in. and under. Work as small as $\frac{3}{16}$ in. can be handled by this method.

Where the pieces have been cut off in a hacksaw, simply spot one end with the center drill and finish both ends on male centers.

This is our delayed issue of Nov. 13-20, 1919. This news is, however, up to date, having been prepared for our Nov. 27 issue.

Sparks from Industry's Forge

Edited by E. C. Porter

Revival of German Machine-Tool Export

SPECIAL CORRESPONDENCE

The report of the German Machine-Tool Builders' Association issued for 1918 contains indications of a strong revival of the German machine-tool export since the end of 1918. While in April, 1918, the total export of German machine tools was only 105 tons at a value of 400,000 marks, it amounted in December, 1918, to 6000 tons, valuing two million marks. In the beginning of the current year the increase became still more marked, as the following figures will show:

GERMAN MACHINE-TOOL EXPORT

	Metric Tons	Value in Million Marks	Average Value per Kg. in Marks
1918			
April	105	0.3	3.88
June	270	0.74	2.73
October	320	1.345	4.20
December	1857	6.024	3.24
1919			
April	3300	12.	3.65

Since the lifting of the blockade in July, 1919, the export of machine tools has increased in leaps and bounds. In August, 1919, over 11,000 tons of machine tools, valuing over 40 million marks, have been exported. This is a rough estimate. The exact figure is not yet available; it is however expected to be even higher than the figure quoted. This figure appears very high in comparison to previous years.

The following figures demonstrate the annual production of the German machine-tool industry and the amount exported therefrom in the years between 1911 and 1918:

	Production in Metric Tons	Sale Price per Kg. in Marks	Total Sale Price in Millions of Marks	Export in Millions of Marks
1911	330,000	1	330	65
1912	550,000	1	550	85
1913	950,000	1	950	100
1914	850,000	1.10	935	75
1915	530,000	1.50	695	40
1916	330,000	2	660	24
1917	680,000	2.50	1720	12
1918	260,000	3	780	20

As is shown, the total export in the record year, 1913, was only 100 million marks, or 100,000 metric tons. The monthly average of this year is 8⅓ million marks, or 8333 metric tons. Last August exports exceeded the above figures both as regards weight and value. In fact the value of machines exported in this one month is not far distant from the export of all of 1911.

The "reparation" machines for France and Belgium are not included in the above figures. They acted however in a peculiar way as a stimulant on the export of German machine tools. The French and Belgian manufacturers, who are in great need of such machines, are pressing for delivery and have in many cases come to Crefeld, the seat of the Allied Commission for reparation machines, to look after their interests. Delivery, however, got slower and slower and more pressure was exerted, and the French and Belgian claimants became rather impatient. In many cases they could not wait and bought machines on the open market, paying high prices for quick-delivery tools. Shops and trading houses in Cologne are extremely busy trying to cope with the constantly increasing demand. In this way, the delivery of reparation machines has taken a turn very favorable to Germany.

The figures quoted above have been carefully compiled by the newly installed bureau of statistics of the German Machine-Tool Builders' Association. They are noteworthy in more than one respect. They do away with the common belief that from one-third to one-half of the total output of German machine tools were exported. The true ratio of home consumption to export as ascertained by export statistics has been a great surprise in German machine-tool circles. The home consumption has been much larger than was commonly expected.

* * *

The O. S. Walker Co. Sells Its Business and Property

The business and property of the O. S. Walker Co., Worcester, Mass., manufacturer of grinding machines and magnetic chucks, has been sold by Oakley S. Walker to a group of men connected with the machine-tool and supply business, and the reorganization of the corporation has been completed and the new management has assumed control. The name of the company will remain unchanged. The sale includes the company's plant on Rockdale St., Greendale.

The officers of the company now are: President, W. B. McSkimmon, Boston; vice president, J. H. Drury, Athol; general manager, secretary and treasurer, Clayton O. Smith; the third director being William F. McCarthy, Boston.

Mr. Smith was until recently sales manager of the Norton Grinding Co. Isaac F. Williams, who has been manager of the business for Mr. Walker for the last four years, will remain with the company.

Trade Currents from Cleveland, Chicago and Philadelphia

CLEVELAND LETTER

Spotty business is the keynote to the machinery market at the moment. Cleveland manufacturing and distributing interests point out that although steel production is being resumed, there is a considerable uncertainty among manufacturing interests generally as to the immediate outlook both as regards materials and labor, and for the most part there is little disposition to extend activities just now. The automobile industry still stands out as the principal consumer of equipment, but it is claimed by local machinery interests that day-to-day buying is still noted, with no large orders or plant extensions in view. The business being placed is generally confined to single machines of one type or another, or ones and twos of these types where orders are sufficiently large for finished products, or where there is still a surplus of stock and certainty of labor to turn it out.

In not a few instances, machinery interests are inclined to anticipate these conditions until the turn of the year when both the steel and fuel situations will have been cleared, it is believed. In the Cleveland district steel mills it is claimed by operators that better than 50-per cent. production now is under way and that men are returning to work daily. Union officials claim just the reverse. In any event, it is known that stocks in consumers' hands are low, and that even with maximum production under way, it still would be nearly a month before steel production would be finding its way into natural channels.

Local machinery interests continue to turn their attention toward foreign markets as a means of outlet for their product. Direct advices from representatives of Cleveland producers, who are combing the European markets thoroughly, show that it will be at least two years before any real business will come forward from those sources. In recent advices from the representative of one of the largest machinery manufacturers in this country, located in Cleveland, it is shown that there is a strong disposition for some of the countries that were involved in the war to keep as much business at home as possible. More important, it is shown that France and Belgium, at the behest of manufacturers in those countries, and business interests generally, are disposed to do more business with Germany, in spite of any public ani-

mosity toward that country. The basis for this argument, these advices show, is the rate of exchange, which places the American dollar too high, and the German mark low.

Local manufacturing interests are still preparing for future big business, and it is largely upon present activities in this direction that machinery outlet is expected to be developed. One of the latest plans to be announced is that of the Cleveland Metal Products Co., which has purchased the three-acre tract and plant of the Malleable Steel Castings Co., adjacent to the metal-products concern's present property. According to Fred W. Ramsey, president, it is proposed to raze some of the acquired buildings, and erect one large structure, to cover half of the tract, for the increased production of oil-burning devices.

Another step toward active operations in this district is announced in the election of officers and appointment of directors of the Fisher Body Ohio Co., recently incorporated at $10,000,000. Officers include Fred W. Fisher, president of the Fisher Body Co. of Detroit; vice president, Charles F. Fisher; secretary, A. Mendelsohn; treasurer, L. Mendelsohn. Early announcement of the location of the plant in the Cleveland district is promised.

Chicago Letter

The slump in the machine-tool trade which was noted during the closing days of October proved to be only a momentary interruption to the continually growing volume of business in this market. Orders from a wide variety of sources are pouring in on dealers in such quantity as, in many cases, to seriously tax their facilities for handling, and to render practically assured an increase in gross business in November over any preceding month in the year.

Dealers seem to be at a loss, in some cases, to explain the continued demand, particularly for heavy machinery, but it seems to be caused largely by the fact that many shop additions and new plants are approaching completion. Chicago's long-drawn-out lockout in the building trades retarded this development all through the summer, but with the resumption of labor activity, literally scores of enterprises, ranging from a small addition to a machine shop to a large complete industrial plant, are being rushed to completion.

As the time approaches for occupying these new quarters, owners are placing orders for the needed equipment. They uniformly refrain from making public large lists of needs, seeming to prefer to shop around among the various dealers, filling their requirements with numerous small purchases. Recent demand is heavy for large lathes, planing machines and slotting machines, while it is impossible to fill orders for drilling machines of any sort.

Recent inquiries for large bending rolls from manufacturers of railway equipment indicate that the construction of tank cars is going ahead, whether for the packing interests or for the oil companies being unknown at this end of the line. The railroads themselves, notably the Northwestern and the Santa Fé, have purchased some machines recently and the Burlington has been making rather extensive inquiries. Activity on the part of manufacturers of road-building equipment, automobiles and tractors, pumps and conveyer machinery keep demand on the part of these industries very strong.

Manufacturers, seemingly, are having no trouble in securing raw materials, and are able to give somewhat better deliveries than when last reported. With the exception of certain lines of presses, from 60 to 90 days is all that is required for the delivery of any standard items. Dealers in both new and second-hand material have their stocks seriously depleted, their floors presenting an appearance similar to that during the early part of 1918.

Philadelphia Letter

November promises to be an even better month than October for machine-tool dealers in Philadelphia and vicinity. In fact, dealers are quite enthusiastic about conditions in general, and look forward to still greater business within the near future.

Local houses selling second-hand equipment do not appear to be greatly affected by the many Government sales

Large stock of piping at the American Supply Base at Gievres, France, bought by the French Government

of machinery. There is a constant demand for used machine tools of every description, especially for those of the heavier types.

Manufactuers of motor-cycles, automobiles and accessories, and similar classes of goods are buying new equipment such as planing and shaping machines and boring mills in large quantities. Dealers in second-hand tools, however, do not report very many sales to this branch of industry.

The southern states are improving their plants with large quantities of northern machinery, and, as usual, Philadelphia and Cincinnati receive the greater part of this trade.

Long credit is said to be holding up foreign shipment, but several sales have been recorded for Spain and Italy, while many inquiries have been received from India and the Argentine.

There is an unusually great demand for woodworking machinery; and it is believed that, with the coming of spring, business will be so brisk that difficulty will be experienced in the filling of orders. One large local dealer admits that even now it is hard for him to obtain sufficient machines to satisfy the demand.

Dealers in electrical equipment of all kinds also report unusual activity in their line of business.

One Philadelphia machinery firm reports that it has done a very large business in keyseating and drilling machines.

The railroads which have lain dormant for so long while under Government ownership appear to be taking some interest in the machine-tool market again, and the Pennsylvania lines have sent out long lists of requirements from their Pittsburgh offices.

Convention and Exhibition of the American Steel Treaters' Society

Delayed News

The annual convention and exhibition of the American Steel Treaters' Society, the program of which was published in the columns of the *American Machinist* on page 441, was held in the Seventh Regiment Armory, Chicago, Ill., Sept. 23 to 27, 1919. The program and exhibition which had been arranged were of exceptional merit, and it is to be hoped that they may be repeated during the following years and create increasing interest among those concerned with the proper heat-treatment of the steel for mechanical purposes.

The officers of the society who arranged the convention were: President, T. E. Barker; first vice president, A. F. Boissoneau; second vice president, E. J. Janitzky; secretary-treasurer, A. G. Henry; business manager, W. H. Eisenman.

The exhibitors had arranged such an exhibit of its character, and there were so many representatives of the steel, furnace and similar industries, that in this respect the exhibition was of educational value to all who were able to devote the necessary time to it.

The following officers were elected to control the affairs of the Steel Treaters' Society for the ensuing year: President, T. E. Barker, Chicago; first vice president, E. J. Janitzky, South Chicago; second vice president, D. K. Bullens, Philadelphia; secretary, A. G. Henry, Chicago; treasurer, A. F. Boissoneau, Chicago. The new board of directors consists of Julian Pollak, Cincinnati; H. G. Weidenthal, Cleveland; J. Fletcher Harper, Milwaukee; A. F. McFarland, Pittsburgh. W. H. Eisenman will continue as business manager. The time and location of the next convention will be announced later.

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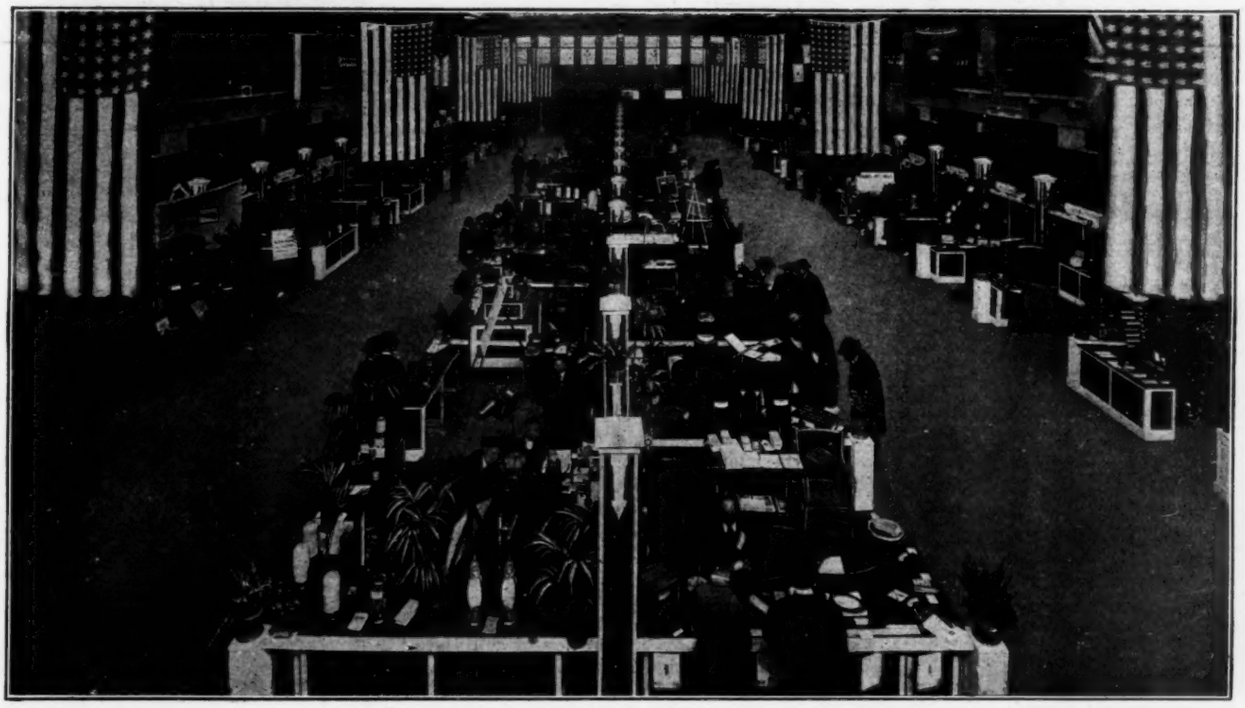
Black & Decker Building a Larger Plant

Ground has been broken and work started on a new and larger plant for the Black & Decker Manufacturing Co., at Towson Heights, Baltimore, Md. The new building will be 100 x 200 ft., erected on the west side of the present plant and directly connected with it. The old plant has a manufacturing floor space of 12,000 sq.ft. and the new building will add 20,000 sq.ft. more, giving a total of 32,000 sq.ft. of manufacturing floor space, not including storehouse, chemical laboratory or the new office building.

The new factory is being erected by the Austin Co., of Cleveland, Ohio. It will be of steel and brick construction and is planned to conform architecturally to the residences which the company is erecting on Joppa Road. With this in view, it will be finished in stucco. Abundant light and ventilation will be provided by the Monitor roof and large windows.

The erection of the new building will include a modern steam-heating system for the entire plant. The plans also include an attractive women's restroom.

It is planned to complete the new factory unit Dec. 1, or sooner, and it should be in full operation shortly after the first of the year. It is said that sufficient additional machine-tool equipment will be installed to give the plant more than twice its present productive capacity.



EXHIBITION HALL OF STEEL TREATERS' SOCIETY

Personals

CARL J. SCHUMANN, secretary of the Hilo Varnish Corp., Brooklyn, N. Y., has been elected president of the National Varnish Manufacturers' Association at its annual meeting in Chicago on Oct. 28.

ARTHUR B. MEAD has been appointed by the Peter A. Frasse & Co., Inc., New York, as district sales manager for the territory covering Philadelphia, middle Pennsylvania, southern New Jersey and the states of Virginia, Delaware and Maryland. Mr. Mead will have his headquarters at its Philadelphia office, 625 Arch St.

OSCAR P. WODACK, formerly district manager of the James Clark, Jr., Electric Co., has entered the electric tool business as a manufacturer of portable electric drilling and grinding machines with offices at 23-27 South Jefferson St., Chicago. The new company is successor to the Electric Tool Repair and Maintenance Co., and will build a line of Wodack electric tools.

Trade Catalogs

Motor-Driven Tools. Stow Manufacturing Co., Inc., Binghamton, N. Y. Bulletin No. 103, pp. 28, 6 x 9 in., illustrating and describing the line of portable tools invented and manufactured by this company.

Welding Repairs. Wilson Welding Co., Ltd., 2 Rector St., New York City. Catalog, pp. 15, 9 x 6 in. This is an illustrated catalog of welding repair jobs done by its service department.

Machine Tools. St. Louis Machine Tool Co., St. Louis, Mo. Catalog, No. 16, pp. 24, 11 x 8½ in. An illustrated and descriptive catalog of its various machines; specifications also included.

D-B Decarbonizing Outfit. Davis-Bournonville Co., Jersey City, N. J. Folder, 3½ x 6¼ in., illustrated. This folder describes an outfit for burning out carbon deposits in gas-engine cylinders.

Oxy-acetylene Welding and Cutting Apparatus. Admiral Welding Machine Co., Kansas City, Mo. Catalog, 7½ x 5½ in. This catalog shows the development of its welding equipment; the price list is also given.

Typical Graphic Records. The Esterline Co., Indianapolis, Ind. Booklet, 8½ x 11 in., 24 pages, illustrated. An 18-year collection of charteristic curves, covering various industries and special operations, has been reproduced in this booklet.

Steels of the Century. Century Steel Co., of America, Poughkeepsie, N. Y. Booklet, 6½ x 4 in., 10 pages. The company's high-speed steel "Centurian Superior," is personified and it tells the story of its inception, melting and use.

Chains and Buckets. Howe Chain Co., Muskegon, Mich. Catalog No. 100, pp. 22, 11 x 7½ in. A catalog containing illustrations of its chains and malleable elevator buckets; also tables of dimensions and strength, and price list. Catalog will be sent upon request.

Belt User's Book. J. E. Rhoads & Sons, Wilmington, Del. Booklet, pp. 54, 6 x 4 in. This booklet contains rules, suggestions, and information to those who are interested in machinery, and it is of real value in solving everyday problems of transmission.

Reclaiming Cutting and Hardening Oils. The De Laval Separator Co., 165 Broadway, New York City. Bulletin No. 101, pp. 16, 10½ x 8 in. It gives complete instructions for the installation and operation of its method of reclaiming and hardening oils; also several illustrations of its process.

Officers Elected at the Founders' Convention

At the close of the convention at the Hotel Astor of the National Founders' Association last week William H. Barr, of Buffalo, was reëlected president. The other officers are vice president, Julius Goslin, of Birmingham, Ala.; A. E. McClintock, of Chicago, commissioner, and J. M. Taylor, Chicago, secretary. Papers were read by H. B. Bole, vice president of the Hydraulic Pressed Steel Co., of Cleveland, and L. R. Clausen of Deere & Co., Moline, Ill.

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Dow Metal—A Light Alloy

Recent production of alloys of magnesium have opened the way for their application in the construction of automobiles and airplanes.

Dow Metal, a casting alloy developed by the Dow Chemical Co., Midland, Mich., is said to have a specific gravity of 1.80 with a tensile strength of over 20,000 lb. per square inch and this strength may be increased to 30,000 lb. per square inch by certain methods of heat-treatment.

It is claimed that this metal may be cast either in sand or metal molds and that the castings resemble malleable iron in toughness and resistance to shock; that it is one-fourth the weight of malleable iron, and that weight for weight it is twice as strong.

The manufacturer states that a cylindrical casting 3 in. in diameter and 3 in. long, closed at one end and having a wall $\frac{1}{16}$ in. thick, subjected to lengthwise compression, required a pressure of 40,000 lb. to deform it and 68,000 lb. to break it and that, before breaking, it was compressed 9 per cent. of its original length.

It is also stated that pistons made of this alloy have been tested in automobile engines under all manner of conditions with highly satisfactory results.

The manufacturer has organized a special research department for the development of its alloys and will be pleased to receive suggestions and inquiries relative to the possible use of them in work requiring combined strength and lightness.

Optical Glass. Bausch & Lomb Optical Co., Rochester, N. Y. Catalog, pp. 20, 10 x 6½ in. This catalog contains treatises on the theory and history of optical glass manufacture; also including the story of its pioneer work along this line in America, before and during the war.

Flexible Shafting. Stow Manufacturing Co., Inc., Binghamton, N. Y. Bulletin No. 104, pp. 86, 6 x 9 in. It gives the price, size, and weight of flexible shafting for various uses. Illustrations show some of the uses for flexible shafting.

Bulletin No. 270. Walter A. Zelnicker Supply Co., St. Louis, Mo. Pp. 56, 3½ x 8½ in. It gives the size, weight and conditions of rails, track accessories, locomotives, cars, trucks, machinery for power and industrial plants, contractor's equipment, all kinds of pipe, steel piling, tanks, etc.

Centrifugals Hydro-Extractors. The Tolhurst Machine Works, Troy, New York. Catalog No. 8, pp. 43, 11 x 8 in. A catalog describing and illustrating its methods for extracting and separating liquids from textiles, fibers, crystals, sludges and kindred materials; also for removing and reclaiming cutting oils from chips, turnings and small metal articles.

Obituary

HENRY LAURENCE GANTT, well known for his work in industrial lines, died Sunday, Nov. 23, 1919. Mr. Gantt was born in Calvert County, Maryland, May 20, 1861. He attended the McDonogh School, Baltimore County, Md.; in 1880 he won the degree of A. B. at Johns Hopkins, and in 1884 the degree of M. E. at Stevens' Institute. He joined the American Society of Mechanical Engineers in 1888, was manager, 1908-1911 and vice president, 1913-1915. He was also a member of the Society of Naval Architects and Marine Engineers, American Geographic Society and Beta Theta Pi. He belonged to the Engineers' Club, Machinery Club, Johns Hopkins Club; was author of "Work, Wages and Profits," and several other books, and a large number of articles on industrial management problems. For some time he has had a consulting office in the Singer Bldg., New York City. His residence was Montclair, N. J.

HENRY LAURENCE GANTT

Export Opportunities

The Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., has inquiries for the agencies of machinery and machine tools. Any information desired regarding these opportunities can be secured from the above address by referring to the number following each item.

A Spanish merchant established in the United States, having representatives in Spain, is about to visit that country and desires to secure agencies for the sale of tools, hardware, lathes, electrolitic copper wire, iron plates, motors, dynamos, electrical appliances. References. No. 30,646.

A general agency is desired by an engineer in Belgium for the sale of machinery and equipment of all kinds for steam, electric, and hydraulic plants, railroads, manufacturing plants, and machine shops, all steel products, hardware and tools, belting, chemicals, and all construction and building equipment and supplies. Quotations should be given c.i.f. Antwerp. Correspondence may be in English. No. 30,813.